Vol. 14 DECEMBER, 1931 No. 12

Journal

of the

American Ceramic Society

Abstracts
Vol. 10, No. 12

Bulletin
Vol. 10, No. 12

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: J. T. LITTLETON, *Chairman;* L. NAVIAS, L. J. TROSTEL, A. E. R. WESTMAN, ROSS C. PURDY.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

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PROGRESS REPORT ON INVESTIGATION OF SAGGER CLAYS. VI
The Life of the Sagger as Affected by Varying Certain Properties[1]

By R. A. Heindl and L. E. Mong

ABSTRACT

This report presents the results obtained in a study of sagger bodies and represents an enlargement of a similar study of a preliminary nature, the results of which have been published. The clays and grogs are combined to give bodies having wide variations in body structure and in the several properties which were studied. Data are given on the modulus of elasticity, transverse breaking strength, plastic flow, thermal expansion, and resistance to failure due to heat shock of thirty-five laboratory prepared bodies and ten commercial bodies after firing at from one to three different temperatures. For comparative purposes data are given on two series of bodies, the one series containing coarse grog and the other fine grog. In addition body compositions were varied in order to compare the effect on sagger life of using open- and close-firing grogs.

I. Introduction

Data in the first Progress Report[2] served as a basis for grouping fifty-one sagger clays into five divisions according to their firing characteristics.

Thermal expansion of the clays was given in the Second Progress Report.[3]

Seventeen clays representative of the five groups first reported on were selected for determination of the transverse strength and changes in deformation with increments of load at (*a*) room temperature, (*b*) the temperature (ranging from 350 to 925°C) at which saggers made from these clays failed in an air-quenching test described in the First Report, and (*c*) at 750°C. The results of these tests were published in a Third Progress Report.[4]

The results of tests similar to those described in the Third Report but made at 1000°C, together with some observations on the elastic and plastic characteristics of the various fired clays, were reported in a Fourth Progress Report.[5]

Thirty-nine different sagger bodies, whose composition was based on the fundamental data reported, were prepared and small experimental saggers and specimen bars were made from them. After firing, the saggers were tested for resistance to failure due to thermal shock and the bars, for various physical properties. The results obtained, together with some preliminary

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[1] Publication approved by the Director of the Bureau of Standards, U. S. Department of Commerce. Received August 13, 1931.

This report is being published in greater detail in the December, 1931, issue of the Bureau of Standards, *Journal of Research*.

[2] R. A. Heindl, *Jour. Amer. Ceram. Soc.*, **9** [3], 131–43 (1926).

[3] R. F. Geller and R. A. Heindl, *ibid.*, **9** [9], 554–74 (1926).

[4] R. A. Heindl and W. L. Pendergast, *ibid.*, **10** [7], 524–34(1927).

[5] R. A. Heindl, *ibid.*, **10** [12], 995–1004 (1927).

indication of how the various properties are related to the life of the sagger, were published in a Fifth Progress Report.[6]

Since the results given in the fifth report were of a preliminary nature, it was considered advisable to continue the study of sagger bodies with special reference to the effect of porosity, thermal expansion, and moduli of rupture and elasticity on the resistance of saggers to failure due to thermal

TABLE I

SAGGER BODY NUMBERS AND COMPOSITION

(Table does not include bodies furnished by potteries)

Sagger* body No.	Laboratory number of bond clays	Percentage of each clay used	Laboratory number of grog clays	Percentage of each grog used
1BF, 1BC†	21, 47	50	15, 42	50
2BC	21, 47	50	19, 24	50
3BF	21, 50	50	19, 24	50
4 BF, 4BC	10, 40	50	5, 41	50
5BF, 5BC	26 51	75 25	26, 51	50
6BF, 6BC	19, 26, 51	33⅓	26, 51	50
7BF, 7BC	22 46	40 60	28, 36	50
8BF, 8BC	11 28 50	25 25 50	9, 43	50
9BF, 9BC	43, 44	50	43, 44	50
10BF, 10BC	8, 45	50	8, 45	50
11BF, 11BC	8, 45	50	45	100
12BF, 12BC	8, 45	50	8	100
13BF, 13BC	22 29	40 60	1, 12	50
14BF, 14BC	39, 44, 45	33⅓	2, 4	50
15BF, 15BC	21, 46	50	21, 46	50
16BF, 16BC	21, 46	50	21	100
17BF, 17BC	21, 46	50	46	100
18BC	Commercial mix	100	22, 39	50
19BC	" "	100	22	100
20BC	" "	100	39	100

* Bodies containing the fine grog are designated F, those containing the coarse grog, C. The letter, B, is used with the body number to differentiate these bodies from those in the preceding reports.

† Bodies 1BF to 4BC inclusive contained grog prepared from saggers used for tests referred to in the preceding report (see footnote 6) and may be identified by the numbers of the grog clays. The remaining bodies contained grog prepared from clays independently fired and afterward mixed in the proper proportions.

shock. This sixth report contains the results of tests made on 35 different sagger bodies as well as on ten sagger bodies furnished by industrial potteries, all of which were fired at from one to three different temperatures.

II. Sagger Body Compositions

All of the bodies contained equal weights of clay and grog. Variations in the bond clay and grog were made by using different combinations of

[6] R. A. Heindl and L. E. Mong, *J. Amer. Ceram. Soc.*, **12** [7], 457–80 (1929); also Bureau of Standards, *Research Paper*, No. 104.

clays and of grogs. The grogs used were fired at approximately 1230°C (cones 9 to $9^1/_2$) for $1^1/_2$ hours.

Table I shows the compositions and laboratory numbers of these bodies.

The majority of the bodies were in two series; (1) compounded with comparatively coarse grog, designated as "C" and (2) compounded with the finer grog designated as "F."

The grog sizing and the percentage of each size were as follows:

Material	Passed through sieve No. (U. S. Standard Series)	Retained on sieve No. (U. S. Standard Series)	Percentage of each size
Coarse-grogged body	4	8	20
	8	12	60
	12	20	20
Fine-grogged body	20	40	$66^2/_3$
	40	80	$33^1/_3$

Five bodies were prepared using dense and porous grogs and a factory-prepared sagger mixture.

III. Description of Specimens

The specimens were prepared and tested in a manner described in the Fifth Progress Report. A large proportion of the saggers and specimen bodies were fired at three temperatures, *i.e.*, 1190°C (cones $7^1/_2$ to 8), 1230°C (cones $9^1/_2$ to 10), and 1270°C (cones 11 to 12).

IV. Results

(1) Rupture and Shrinkage (Unfired Bodies) The average modulus of rupture for the laboratory-prepared bodies which contained the fine grog was 155 pounds per square inch, for bodies which contained the coarse grog 115 pounds per square inch, and for commercial bodies 80 pounds per square inch.

The average linear drying shrinkage for the fine-grogged bodies was 42%, for the coarse-grogged bodies 3.0%, and the commercial bodies 3.4%.

(2) Properties after Firing Porosity values represent the average of not less than three determinations.

The total linear thermal expansion determinations were made on specimens prepared from the ruptured bars used for the strength and elasticity tests. Check determinations were made on all specimens.

The thermal expansions change with the degree of heat treatment, but not consistently in the same direction or of the same magnitude for the several mixes, due to the various types of clays used. The typical thermal expansion data for two typical bodies are given in Fig. 1. Body 4BC shows little change in expansion when tested after firing at each of three temperatures, whereas the expansion of body 2BC decreases with increased tem-

perature of firing. The great difference in the rate of expansion below 200°C is very noticeable in these two bodies.

Moduli of rupture and elasticity values were obtained at three different temperatures for all bodies (two only for 1BC-8). Check determinations were made of all bodies (one only for 4BC and 20BC) at ordinary temperatures, and of twenty bodies at 1000°C. In all cases the values obtained for any one body were within approximately 10% of the mean.

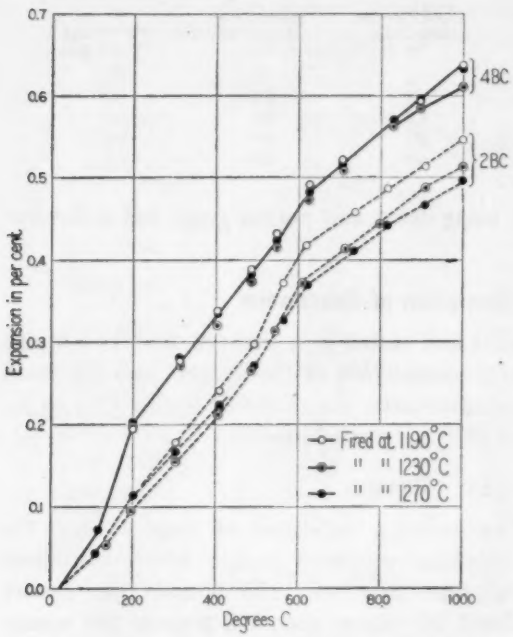

FIG. 1.—Showing the linear thermal expansion of two typical sagger bodies fired at three different temperatures. The great difference in total expansion at 200°C is well illustrated.

The computed maximum outer fiber strain (elongation) values show how the elongation of the material decreases in most cases at the higher temperature. The data show that the fine-grogged bodies have a greater fiber elongation before rupture than the coarse-grogged bodies.

The maximum outer fiber strain was not computed with the data obtained at 1000°C; instead, a study was made of the plastic deflections of the bodies which was more satisfactory.

(3) Plastic Flow Deflection results were obtained at 1000°C and represent the total plastic deflection in inches at the end of ten minutes with (1) a load of 120 pounds per square inch, and (2) a load of 240 pounds per square inch applied midspan of the 1- by 1- by 12-inch specimens on a 10-inch span.

Within the limits of firing temperatures and grog sizes used, the following information relative to plastic flow was obtained:

(1) Bodies containing the coarser sizes of grog have a plastic flow decidedly greater than those containing the finer sizes of grog.

(2) The plastic flow decreases with increase of temperature of firing of the specimens. A typical illustration of such changes is shown with body 14BC in Fig. 2. Saggers fired at the lowest temperature may prove unsatisfactory in service whereas if fired at the highest temperature may prove to

be quite satisfactory. Data represented by these curves illustrate further the undesirability of heavily loading saggers which have not been fired at sufficiently high temperatures.

(3) The percentage increase in plastic flow when loads of 120 and 240 pounds per square inch are used is decidedly different for the different clays.

(4) Bodies containing a high percentage of silica and a high percentage of flux have a greater plastic flow than bodies containing less silica and

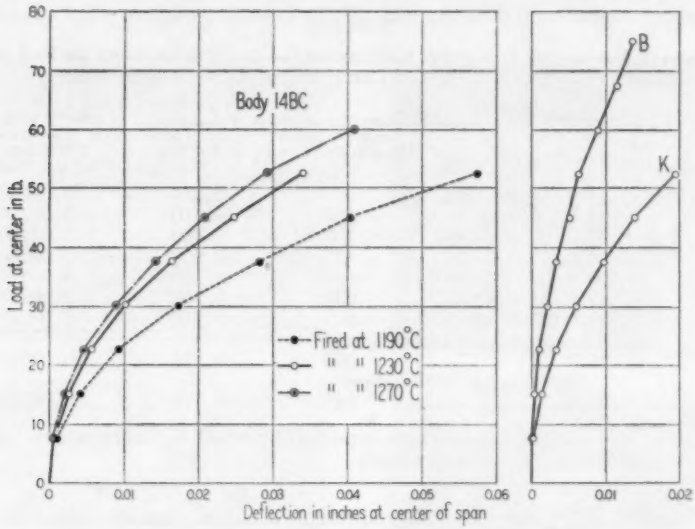

FIG. 2.—*Left.* Showing that the plastic deflection of sagger bodies tested at 1000°C decreases with increase of firing temperature.

Right. Plastic deflections at 1000°C obtained on two commercial bodies after firing at 1230°C.

more alumina with a high percentage of flux. On the other hand bodies high in silica with a low flux content have a low plastic flow.

The plastic deflections obtained on commercial bodies B and K after having been fired at cone 10 are shown on the right in Fig. 2. Body K has a considerably higher plastic flow than body B, but K has a much greater resistance to failure in the thermal shock tests.

V. Discussion

(1) Porosity and Failure A comparison of the average porosity values and average temperatures at which the saggers cracked in the thermal shock test indicated in general that the saggers which had a porosity intermediate between the highest and lowest values showed the least resistance to failure. This is indicated by the average values given

in Table II. H. G. Schurecht found a somewhat similar relation in connection with his study of the spalling losses of fireclay brick in malleable iron furnace linings.[7] To illustrate the point more fully, saggers which had a porosity below 20% as reported in the fifth report were included in these averages.

The values for porosity in Table II represent group relationships which do not hold for individual bodies.

The average temperature at which the coarse-grogged saggers failed was

TABLE II

AVERAGE VALUES OF POROSITY, NATURE OF GROG, TEMPERATURE OF FAILURE, AND PLASTIC FLOW OF ALL LABORATORY-MADE SAGGER BODIES

Total number of bodies	Porosity* (%)	Temperature at which saggers failed in thermal shock test (°C)	Thermal expansion total at 250°C (%)	Total plastic deflection at 1000°C with a stress of approximately 240 lb./sq. in. (inches per 10-in. span)
16	19.0 (16.0–21.9)	600	0.110	0.00525
12	24.0 (22.0–25.9)	530	0.170	0.00175
10	26.0 (26.0–26.9)	500	0.190	0.00200
13	28.0 (27.0–29.9)	475	0.200	0.00150
7	30.0 (30.0–30.9)	525	0.190	0.00175
9	32.0 (31.0–32.9)	630	0.160	0.00175
7	35.0 (33.0–38.0)	800	0.150	0.00275
	Coarse grogged bodies alone			
	26.7	605	0.171	0.00240
	Fine grogged bodies alone			
	26.3	535	0.171	0.00143

* The average porosity in each case included those bodies coming within the range of porosity values given in the parentheses.

605°C and that of the fine-grogged saggers 535°C, an appreciable difference.

(2) Expansion The averaged total expansions from atmospheric temperature to 250°C correspond with the grouping of porosity values. The maximum expansion occurs with bodies which have a porosity of 28% and in turn fail in the thermal shock test at the lowest average temperature. A comparison of the average thermal expansion values with the average temperatures at which the saggers failed shows that a close relation exists between these two properties.

(3) Deflection The total plastic deflections determined at 1000°C with a stress of approximately 240 pounds per square inch show clearly that the coarse-grogged bodies have decidedly greater plastic flow than the fine.

NOTE: In correlating the properties of the sagger bodies which were determined, it was necessary to separate the data obtained on the coarse- and fine-grogged bodies because of such properties as thermal conductivity and diffusivity which were not

[7] "The Behavior of Fire Brick in Malleable Iron Furnaces," *Trans. Amer. Foundrymen's Assn.*, Vol. XXX, pp. 391–94.

studied and which undoubtedly are not the same in the two types of bodies. Because of the fact that several of the bodies studied were identical except for the sizes of the grog they contained and, because the coarse-grogged bodies showed the greater resistance to failure in the thermal shock test in spite of having the lower computed fiber elongation it must be assumed that the thermal conductivity and other thermal properties have an important effect on the life of the sagger.

(4) Expansion and Fiber Strain

Figures 3 (fine-grogged bodies) and 4 (coarse-grogged bodies) show the relation that thermal expansion (abscissa) and computed maximum fiber elongation (ordinate) bear to the resistance of the saggers to failure when subjected to thermal shock (vertical line). These models illustrate the importance of controlling (1) the thermal expansion and (2) the maximum fiber elongation if it is desired to obtain a high resistance of saggers to failure when subjected to temperature changes.

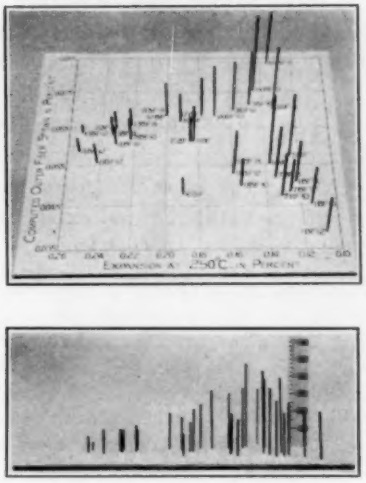

FIG. 3.—*Upper.* Three-dimensional model illustrating the relation between linear thermal expansion (abscissa), computed fiber elongation (ordinate), and the resistance of fine-grogged saggers to failure due to thermal shock (vertical).

Lower. The gradual decrease in resistance to failure due to thermal shock (indicated by the height of the pegs) is accompanied with increase of total expansion. (Read from left to right.)

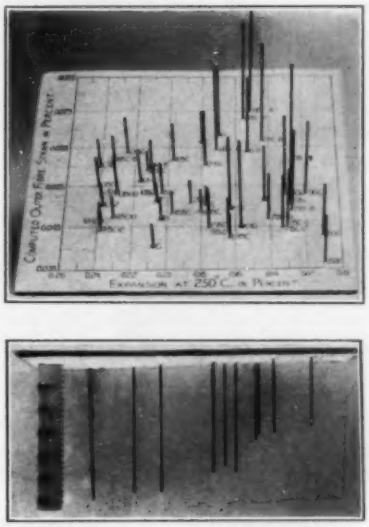

FIG. 4.—*Upper.* Model similar to that given in Fig. 2, but applying the relationship to coarse-grogged sagger bodies.

Lower. The increase in resistance to failure due to thermal shock is accompanied by increased computed fiber elongation. (Read from left to right.)

Figure 3 (upper) and Fig. 4 (upper) show the scattering of the points in the horizontal plane.

Figure 3 (lower), taken along the abscissa, shows the increasing resistance of saggers to failure with decreasing thermal expansion.

Figure 4 (lower), taken along the ordinate axis, indicates that if the thermal expansion is maintained within the range of 0.10 to 0.15%, the bodies show greater resistance to failure, indicated by the height of the pegs, as the computed maximum fiber elongation becomes greater.

The models also show that it is most important to keep the total expansion from 20 to 250°C below 0.18%, or the coefficient for this temperature range below 8×10^{-6}. The necessity for this is especially obvious from an examination of Fig. 3, which shows a sharp line of demarcation from saggers having good resistance to failure to those having poor resistance at approximately the position of the line indicating a total expansion of 0.18%.

The models also show that the resistance of saggers to thermal shock depends more on the thermal dilatation than on the computed outer fiber strain. Furthermore, it is apparently out of the question to develop a sagger of high resistance to failure by increasing the fiber elongation as a result of change in structure of the body if the total thermal expansion from 20 to 250°C is approximately 0.18% or above.

NOTE: The trend of the points is more regular in the case of the fine-grogged bodies (Fig. 3) than those containing the coarse grog (Fig. 4). This is partially due to the fact that the commercial bodies (pegs with circle around the base) are included with the coarse-grogged laboratory prepared bodies. The grog sizing in most of the commercial bodies is more or less haphazard. This would naturally cause some irregularity in the trend of the points. Another cause for irregularity is probably due to the fact that the percentage change in the maximum fiber elongation with increase of temperature is not the same for all bodies.

Commercial body A is an example of the type of body in which the fiber elongation decreases rather rapidly with increase of temperature. Consequently the saggers prepared from this body would fail at a somewhat lower temperature than might be indicated by the computed maximum fiber elongation based on results determined at room temperature and the thermal expansion data.

NOTE: In spite of the care exercised in firing, the temperature within the kiln was sufficiently nonuniform to account for differences in the physical properties between bar specimens and saggers though both were prepared from the same body and fired at the same time. This condition is well illustrated if the porosities of the bars and saggers are compared. Although in most instances the differences are small, attention is directed to the fact that the differences in other properties may be quite pronounced. For example, the data show that a change of 10% in the value for porosity due to firing at the higher temperatures might easily account for a 50% change in modulus of elasticity (bodies 3BF, 14BF). In correlating the results obtained on bar specimens with those obtained on the saggers, some of the apparent discrepancies can easily be accounted for by the slight differences in firing treatment which the ware received.

(5) Body Structure Figure 5 shows the structure of various types of sagger bodies. Body 12BC and commercial body M are of greatly different structure, but have nearly the same linear thermal expansion and maximum fiber elongation.

The reasons for the poor resistance to failure shown by saggers prepared from these bodies is probably due to their comparatively high thermal expansion below 250°C and the rapid decrease in maximum fiber elongation with increase of temperature. The grog particles in body M are not well bonded, but because of the angular shape of the grog which permits interlocking of the particles, a high fiber elongation is obtained. Bodies 2BC

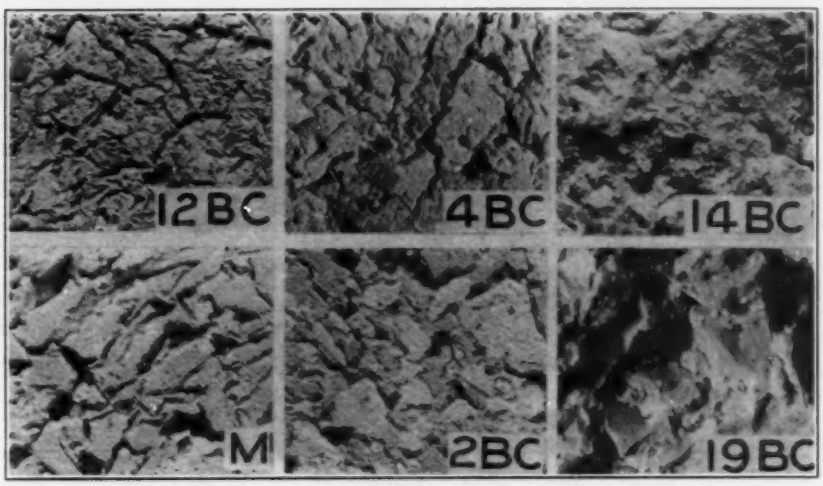

FIG. 5.—Photomicrograph (4×) showing structure of six sagger bodies.

and 4BC have the same computed maximum fiber elongation, but have greatly different thermal expansion.

The porosity of the grog in body 2BC is greater than that in 4BC. As a result, the resistance to failure shown by body 2BC is almost twice as great as that shown by 4BC. Bodies 14BC and 19BC have a relatively low and nearly the same thermal expansion, but the maximum fiber elongation determined at 20°C was very much greater for 14BC than 19BC. As a result of both the favorable fiber elongation and thermal expansivity, saggers prepared from body 14BC did not crack in the heat shock test before reaching 890°C, whereas those prepared from body 19BC cracked at an average temperature of 445°C. A study of 19BC (Fig. 5) shows that the grog used is nearly vitrified. Its effect on the structure was undoubtedly one of the primary causes of the comparatively low resistance to failure of saggers prepared from body 19BC.

Resistance of saggers to failure when subjected to heat shock and when using open- and dense-firing clays as grog in the body is given in Table III, showing the advantage of using open-firing grog rather than the dense-firing.

NOTE: The table is made up of five groups. The bond remains unchanged in each of the bodies of any one group, but the grog is varied. A comparison is intended between the members of a group and not between the groups.

In every case the sagger life is increased as grog of greater porosity is used. Although the fiber elongation is favorably affected with increase of

TABLE III

TEMPERATURES OF FAILURE OF SAGGERS AND POROSITIES OF CLAY AND GROG IN THE BODIES

Group	Body No.*	Average porosity of clays (%)	Average porosity of grog (%)	Temperature at which saggers cracked (°C)
A	1BC	28.0	14.0	635
	2BC	28.0	32.0	865
B	10BF	33.0	33.0	480
	11BF	33.0	36.0	530
	12BF	33.0	30.0	400
C	10BC	33.0	33.0	475
	11BC	33.0	36.0	525
	12BC	33.0	30.0	410
D	15BF	31.0	31.0	460
	16BF	31.0	26.0	415
	17BF	31.0	36.0	550
E	15BC	31.0	31.0	550
	16BC	31.0	26.0	435
	17BC	31.0	36.0	625

* See Table I for body compositions.

porosity, in most cases there are changes in the other properties, such as thermal expansion, which materially affect their life as well.

VI. Conclusion

In most cases, apparently, it is impossible to prepare sagger bodies from the usual run of sagger clays without sacrificing one or more desirable properties for the sake of some one property which the user deems to be paramount to all others. For instance, if it is considered necessary or desirable to have a strong sagger with a low plastic deflection, it would be advisable to eliminate the coarser sizes of grog. The resistance to failure due to thermal shock would necessarily have to be sacrificed to some extent. On the other hand, where resistance to thermal failure is of primary importance and where the load is light so that plastic deflection is of minor consideration, a coarse-grogged body with a low thermal expansion should be chosen. In other words, by knowing the properties of the material entering into a body, it is possible to make saggers having properties which are considered the most desirable for the service intended.

SILLIMANITE KILN REFRACTORIES MADE FROM AN ANDALUSITE BASE[1]

By Frank H. Riddle and Robert Twells

ABSTRACT

Some andalusite refractories are high in transverse strength. Bars 12 inches long, 2 inches wide, and $^1/_2$ inch thick tested across an 11-inch span supported a 45-pound load with $^{13}/_{32}$-inch sag at cone $16^1/_4$ and a $^1/_2$-pound load at cone 34 down with $^1/_{16}$-inch sag. A standard 9-inch brick tested under a load of 50 pounds per square inch at 1525°C showed no deformation. They are relatively constant in volume, are not affected by kiln gases, and tend to improve rather than to deteriorate under continued heating owing to the formation of an increased amount of mullite. Andalusite saggers used at cone 12 are estimated to have stood 180 cycles and are still in good condition. Saggers in continuous use at cone $16^1/_4$ have an estimated average age of $1^1/_2$ years and many are four years old. The andalusite lining of a periodic kiln being fired regularly at 3000 to 3200°F is still serviceable after 110 firings. Cars built of andalusite refractories have given five years of continuous service in tunnel kilns operating at cone $16^1/_4$, whereas cars built of fireclay refractories were unfit for use after three to four months. Side walls, damper boxes, expansion sleeves, and flame shields of Dressler tunnel kilns operating at cone $16^1/_4$ have proved satisfactory.

I. Introduction

Operating conditions of increasing severity have encouraged the development of new refractories. These are called super-refractories, each proving its worth where a fireclay refractory has failed. But even super-refractories are not cure-alls. Each refractory has its particular advantages and disadvantages, and a use for which it is best adapted. As with other refractory materials no one mixture of andalusite is best for every purpose. Different grain sizes, different bonds, additions of other ingredients such as fluxes, and mixtures of ore of different types make a large number of possible combinations of which more than 2000 have been made and tested.

II. Properties of Andalusite Refractories

(1) **P.C.E.** The best mixtures melt above cone 40.

(2) **Load Bearing Capacity at High Temperatures**[2]

(a) Compression Tests A standard 9-inch brick showed no deformation under a load of 25 lb. per sq. inch at 1700°C (3092°F).

A standard 9-inch brick showed no deformation under a load of 50 lb. per sq. inch at 1525°C (2777°F).

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received August 22, 1931.

A contribution from the Research Laboratories of the Champion Porcelain Company, Detroit, Michigan.

[2] The time-temperature schedule was similar to that used in the A.S.T.M. standard load tests.

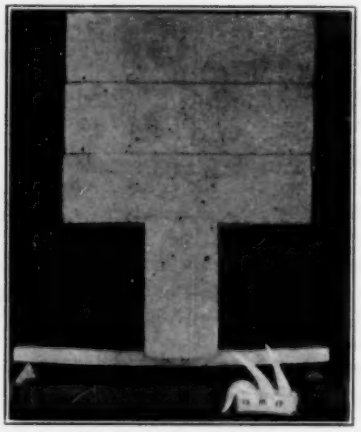

FIG. 1.—Transverse strength test of an andalusite refractory bar. Mix S-1192, load 30 lb., span 11 inches, sag 5/32 inch, cone 16 1/4.

(b) Transverse Strength Tests Standard bars 12 inches long, 2 inches wide, and 1/2 inch thick were tested across a span of 11 inches. The load was applied as nearly as possible at the center of the bar (Fig. 1). The permanent deflection was recorded after the bar was removed from the kiln. The sag tests reported were made in regular production andalusite saggers and this in itself was a severe test of the sagger bottoms.

(1) The bars were fired repeatedly through a Dressler tunnel kiln at 2615°F, cone 16 1/4, and the load was increased after each fire. Some of the best results obtained are given below.

	Dry Pressed		Wet Pressed	
Load (lb.)	Mix S-1231 Sag (inches)	S-1253 Sag (inches)	S-536 Sag (inches)	S-1278 Sag (inches)
0	1/32	0	7/64	0
1	1/32	0	7/64	0
2	3/64	0	7/64	0
4	1/16	1/64	7/64	0
6	1/16	1/32	7/64	1/32
7 1/2	3/32	1/16	1/8	3/64
10	7/64	3/32	5/32	3/32
15	1/8	1/8	3/16	3/32
22 1/2	3/16	7/32	7/32	3/16
30	9/32	5/16	9/32	1/4
37 1/2	13/32	1/2	11/32	3/8
45	Broken	Broken	13/32	25/64
52			Broken	Broken

(2) The loaded test bars were given a long soak at very high temperatures (Fig. 2).

(*a*) Kilns containing the test bars were held at 2800°F for 24 hours. The bars from the best mixtures did not sag under a 1/2-pound load at cone 30 down to 31 1/4.

(*b*) A kiln containing test bars was held at 2900°F for 30 1/2 hours. The bars from the best mixtures showed no sag under a 1/2-pound load at cone 32 down, 34 1/4 tipped, and showed a 1/16-inch sag at cone 34 flat.

(3) Resistance to Thermal Shocks In some instances andalusite refractories have seemed sensitive to thermal shocks, while in others they have proved to be superior.

Resistance to thermal shocks depends upon several factors but prin-

cipally upon the development of mullite in the refractory. An individual andalusite grain when held at a temperature equivalent to cone 13 tends to invert to parallel mullite crystals surrounded by a highly siliceous glass; however, when such a grain is embedded in a refractory mass the inversion takes place more slowly.

In the upper central part of Fig. 3 there is a partially undissociated andalusite grain in the center of a refractory which has been fired to cone 18 with a rather rapid firing schedule.[3] The outer portion of the grain has been changed to mullite and glass. In the lower left portion of Fig. 3 is a totally converted andalusite grain.

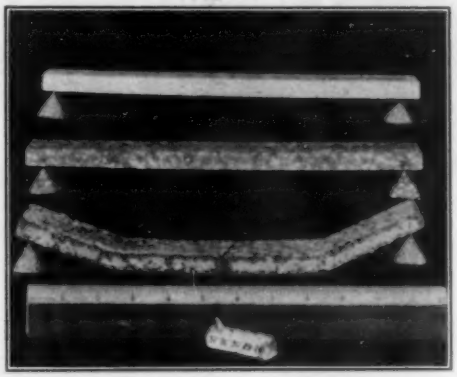

FIG. 2.—A comparative transverse strength test of refractory bars in the same sagger carrying only their own weight at cone 31 down. The two upper test bars are made from two different mixtures consisting chiefly of andalusite; the lower test bar is made from another refractory material which is probably next to the andalusite refractory in load-bearing properties.

It is important that an andalusite refractory be so fired in its initial firing that the whole is bonded thoroughly and a considerable portion converted to mullite. A fireclay refractory tends to vitrify in use and to become more sensitive to thermal shock; an andalusite refractory becomes more resistant to thermal shock in service as the continued high temperature completes the conversion of the andalusite and the bond to mullite.

(4) Stability An andalusite refractory is little affected by the kiln atmosphere and does not tend to disintegrate through oxidation. It gives off no gases injurious to the ware being fired.

An andalusite refractory may shrink or expand in its original firing depending upon the particular mixture being used. Some andalusite mixtures have practically no volume change from the green to the fired state and can be fired to cone 31 without changing from their original molded size. Standard dry-pressed brick made from several mixtures were fired ten times through a Dressler tunnel kiln at cone $16^1/_4$ with no apparent growth. In general, however, over a long period of time at elevated temperatures there is a slight permanent expansion which can hardly be detected in small units.

[3] This photomicrograph does not show the character of the mullite crystals owing to the thickness of the section.

During continuous use within reasonable temperature limits the internal structure of the refractory tends to improve rather than to deteriorate. An andalusite chamber which had been in the hot zone of a Dressler kiln at 2770°F for a period of two years and four months was almost pure white in color, due evidently to the volatilization of at least part of the iron and other fluxes originally present.

FIG. 3.—A photomicrograph with crossed nicols (mag. 100 ×) of the structure of an andalusite refractory fired to cone 18. (A) unconverted andalusite, (AM) mullite and glass formed by dissociation of andalusite, (Q) quartz now inverted to cristobalite. Most of the small clear bright areas are corundum and the small dark areas dissociated andalusite.

Figure 4 shows the large size of the mullite crystals which have developed in parallel orientation in a dissociated andalusite fragment. The darker areas between the mullite crystals represent glass which is probably largely cristobalite; in the center is an area of large and small, elongated, and square mullite crystals in random orientation. This area comprises mullite and glass developed in the original bond, which now acts as a binder for the body. The glass forms in rounded drops or blebs between the larger elongated, parallel mullite crystals (Fig. 5).

(5) Mechanical Strength An andalusite refractory is very hard and strong when properly fired. This permits handling with a minimum of breakage.

(6) Molding and Firing Qualities Andalusite refractories are made in the usual ways by both dry and wet methods with no great difficulty. Mixtures low in clay require the addition of organic binders. Like other refractories high in nonplastic material, andalusite refractories are difficult to fire. The wet-pressed or pugged shapes can be fired fairly easily, but those dry-pressed must be supported carefully in setting to prevent kiln marking and cracking. The ideal setting and firing procedure would be to place the ware one layer high on tunnel kiln cars, particularly when a piece is thin or fragile; heavy blocks and brick, however, have been satisfactorily set on each other up to four feet high.

III. Results in Kiln Parts and Furniture

(1) Periodic Kiln Linings Fireclay brick kiln linings are satisfactory except at high temperatures. For severe conditions andalusite refractories are proving satisfactory. One small periodic kiln using oil has had 110 firings at 3000 to 3200°F.[4]

In several of these firings the temperature was held at 3000°F for as long as a week. The burner ports and lining are still in good condition. The crown of the kiln is made of andalusite brick and is portable (Fig. 6). Despite the fact that the crown is often removed while the kiln is very hot the brick show no signs of spalling. Several other small kilns show similar results.

A larger periodic kiln, 10 feet inside diameter and 6 feet to the spring of the crown is lined completely with the andalusite refractories and has been fired several times to cone 26. The furnaces, side walls, and crown are in excellent condition.

FIG. 4.—Structure of an andalusite refractory exposed to about 2770°F for 2½ years. (AMG) left, mullite crystals developed in a dissociated andalusite fragment, (M) center, mullite and glass developed as the groundmass and acting as a bond, (C) corundum (mag. 100 ×) crossed nicols. Large black areas are holes in the slide.

(2) Tunnel Kiln Refractories Andalusite refractories were used in constructing the side walls and other parts of a Dressler tunnel kiln which operated at cone 16 ¼ (2615°F). The kiln ran continuously for two years and four months. The andalusite refractories, still in excellent condition, were cleaned and relaid for another run.

Andalusite refractories were used for the side walls, damper boxes, expansion sleeves, and flame shields in a more recently built Dressler tunnel kiln also operating at cone 16¼ (2615°F). This kiln has already been operating for one year and six months.

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[4] The kiln furniture used in this case consists of andalusite saggers and rings set from 5 to 9 feet high in the kilns and carrying a heavy load of pyrometer tubes. The life of the saggers and rings is excellent.

The flame shields are worth special mention (Fig. 7). They protect the forward burners inside the chambers from the effect of the flame from burners behind them. The flame shields thus receive the full force of the oil flame from the rear burners. The temperature in the chambers at this point is about 2770°F and the temperature of the flame shields is still higher.

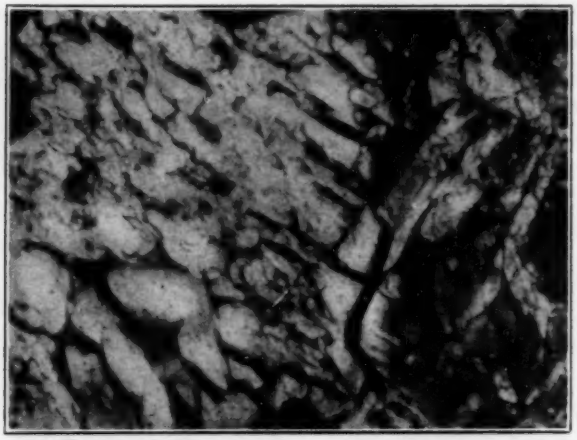

FIG. 5.—Taken with crossed nicols. The small dark isotropic areas represent glass; the light portions are mullite crystals.

The need has long been felt for a refractory for Dressler kiln chambers that would not oxidize or "grow" in service and yet would have sufficient hot strength to stay rigid at long continued high temperatures. Several kilns containing andalusite test sections are now in operation. In one kiln recently closed down the chambers were found to be in excellent condition after two years of service.

It has been thought necessary to use in kiln chambers a material which has a very high thermal conductivity. The lower thermal conductivity of andalusite chambers has not proved a disadvantage; in fact it has helped to eliminate "hot spots" in the kiln.

The upper parts of tunnel kiln cars are also being built with andalusite refractories. The average life (at cone $16^1/_4$) of cars built of fireclay refractories was approximately 20 cycles. Some cars built of andalusite refractories have had 365 cycles and are still in use after five years of continuous service.

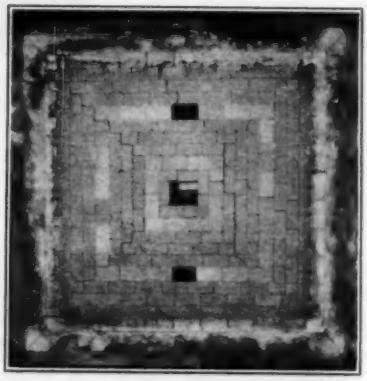

FIG. 6.—View looking up at the portable crown of a small periodic kiln. The crown is built of andalusite wedge brick which show no tendency to spall even after severe thermal shocks.

(3) Saggers Seventeen andalusite saggers, steam pressed and fired to cone $16^1/_4$, are still in service after about 180 cycles in an

electrical porcelain plant.[5] The saggers have not been mended and the bottoms have not sagged although the loads carried ranged from 22 to 60 pounds.

In one plant ware is fired to cone $16^1/_4$ (2615°) in Dressler tunnel kilns operating on a 72-hour cycle. Each sagger is 15 inches outside diameter, $^5/_8$ inch wall thickness, $^7/_8$ inch bottom thickness, and carries a load of 10 to 12 pounds uniformly distributed. Andalusite saggers have been used in this plant since late in 1926. In 1930, only 1631 or 0.35% of the total number of the saggers were scrapped due to breakage. The average sagger now in use is $1^1/_2$ years old and has had 68 cycles. A service record covering a certain lot of saggers shows that these have had 100 cycles without having been mended. The use of wads has been found unnecessary.

FIG. 7.—Andalusite flame shield assembly which has since been in service for one year and six months at over 2770°F.

The direct cost of saggers in this plant has been reduced about 75% by using andalusite saggers and the indirect savings have been of greater importance. There have been no car wrecks in the tunnel kilns due to sagger failure. Injurious gases which had tended to discolor the body have been eliminated; the glaze now has a better luster and contains fewer seeds; and, in general, the quality of the ware has been greatly improved.

IV. Conclusion

The outstanding characteristic of andalusite refractories is an unusually good load-bearing capacity at high temperatures, especially remarkable where tensile and shearing stresses are involved. Relative freedom from volume changes and attack by kiln gases are other important properties. These qualities combined with a tendency to improve rather than to deteriorate under continued heating should make andalusite refractories a valuable addition to the field.

Acknowledgment The writers acknowledge helpful suggestions of J. A. Jeffery. The photomicrographs and petrographic work were furnished by A. B. Peck.

CHAMPION PORCELAIN COMPANY
DETROIT, MICHIGAN

[5] This electrical porcelain plant ordinarily uses fireclay saggers made on a steam press. The ware carried consists of heavy insulators which are fired to cone 12 in tunnel kilns operating on a 96-hour cycle. The life of the fireclay saggers is about 15 cycles and during use their bottoms sag badly.

PROPORTIONING THE GRAIN SIZE IN CLAY REFRACTORIES[1]

By Stephen M. Swain[2] and Stuart M. Phelps[3]

ABSTRACT

A brief review is given of previous work pertaining to proportioning of the particle sizes. Experimental work presented has to do with the proportioning of three sizes of flint clay. To the proportioned particle sizes there were added different amounts of plastic or bond clay. There are given the effects of proportioning upon density, porosity, and change during firing. Clays from two producing districts were used, and although the experimental work on these was comprehensive, similar work should be continued in plant-scale operations. The summary presents the benefits which may be expected from proportioning particle sizes of fireclay mixes used in refractories.

I. Introduction

This study was conducted as a part of an investigation of the shrinkage of clay refractories. It was believed that much could be learned from varying proportions of definite particle sizes: that the percentage and sizes of pore spaces should have, together with plastic clay, a pronounced effect upon the shrinkage during long periods of heating. Furthermore, it would be advantageous to use flint clay in the highest percentage consistent with working properties of the green mix and strength of the fired brick and this is possible only by proportioning different sizes of flint clay and combining these with different percentages of bond clay. Since very little work had been reported on this subject, it was decided to conduct a comprehensive study.

(1) Recorded Information When a vessel is filled with perfect spheres[4] of the same diameter and symmetrically piled, the volume of voids will be equal to 26% of the total, regardless of the size of the spheres. The volume of voids, however, may be reduced to 20% by adding spheres of two different and smaller diameters, (*a*) 0.414 times the diameter of the original and (*b*) 0.222 times the original. Such an aggregate[5] would consist of 95.44% of the original spheres and 3.29% of the next size, with 1.33% of the smallest size. Fuller[6] reported that with

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Canada, February, 1930 (Refractories Division). Received July 9, 1931.

[2] Formerly an Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] Senior Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[4] F. W. Taylor and S. E. Thompson, Concrete, Plain and Reinforced, John Wiley & Sons, 1916.

[5] Robert H. McNeilly, "Sand for Concrete and Cement Mortar Should Have a 'Jump' in Grading," *Eng. Rec.*, **72** [22], 659 (1915).

[6] Fuller and Thompson, "The Laws of Proportioning Concrete," *Trans. Amer. Soc. Civil Engineers*, **59**, 67–172 (1907).

spheres of equal diameter, it is necessary that they be placed geometrically in order to have less than 44% voids.

Feret[7] found that in combinations of coarse, medium, and fine particles the greatest density was obtained when the percentage of coarse material ($3^1/_2$- to 9-mesh) was twice that of the fine (32-mesh and finer) and all of the medium-sized material (9- to 32-mesh) was eliminated.

Fuller and Thompson[6] found that for the densest mixtures of material a combination of a parabola and a straight line was obtained when the percentage of material passing a given screen was plotted against the size of the opening of the screen, and furthermore that the mixture which produced the greatest density varied for different materials. For example, crushed stone would require a different mixture of particle sizes than would gravel. The United States Bureau of Standards[8] found that in using widely different materials a still greater variation could be expected.

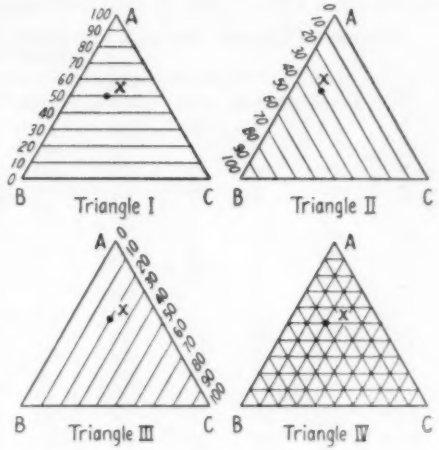

FIG. 1.

Rigg[9] showed that the strongest sagger bodies were obtained when the particle sizes corresponded to the parabola formula of Fuller. Kirkpatrick[10] reported that the strongest sagger bodies were obtained when 50% of the grog was 20- to 40-mesh and the other 50% would pass 80-mesh. The weakest bodies were obtained from the coarse grog mixtures.

Hewitt Wilson[11] shows on a triaxial diagram the bulk specific gravity of various mixtures of mullite grains obtained by jarring these in a graduate. The composition for a maximum density is approximately 60% of ma-

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[7] Feret, "Sur la Compacité des Mortiers Hydrauliques," *Annales des Ponts et Chaussées*, Vol. II (1892).

[8] R. J. Wig, G. M. Williams, and E. R. Gates, "Strength and Other Properties of Concrete as Affected by Materials and Methods of Preparation," Bur. Stand., *Tech. Paper*, No. 58.

[9] Rigg, "The Application of the Grog in Fire Brick Manufacture," *Met. Chem. Eng.*, **8**, 523–25 (1910).

[10] F. A. Kirkpatrick, "The Effect of the Size of Grog in Fire Clay Bodies," *Trans. Amer. Ceram. Soc.*, **19**, 268–300 (1917).

[11] Hewitt Wilson, Ceramics-Clay Technology, McGraw-Hill Book Co., 1927, pp. 105–106.

terial larger than 35-mesh, 10% between 35- and 100-mesh, and 30% smaller than 100-mesh.

II. Study of Method Employed

Three particle sizes of flint clay were mixed in all possible combinations in steps of 10%. The data obtained were plotted on triaxial diagrams.

NOTE: Each apex of an equilateral triangle designates 100%, respectively, of the three constituents. In Fig. 1, Triangle I, the apex *A* represents a value of 100% of constituent "A"; while the base-line *B-C* represents zero percentage. Upon equally dividing the perpendicular distance between *A* and line *B-C* into ten parts by lines

TABLE I

RATIOS OF COARSE, MEDIUM, AND FINE PARTICLE SIZES OF FLINT CLAY IN THE VARIOUS MIXES

Mix No.	Coarse	Medium	Fine	Mix No.	Coarse	Medium	Fine	Mix No.	Coarse	Medium	Fine
1	100	0	0	22	40	60	0	46	10	90	0
				23	40	50	10	47	10	80	10
2	90	10	0	24	40	40	20	48	10	70	20
3	90	0	10	25	40	30	30	49	10	60	30
				26	40	20	40	50	10	50	40
4	80	20	0	27	40	10	50	51	10	40	50
5	80	10	10	28	40	0	60	52	10	30	60
6	80	0	20					53	10	20	70
				29	30	70	0	54	10	10	80
7	70	30	0	30	30	60	10	55	10	0	90
8	70	20	10	31	30	50	20				
9	70	10	20	32	30	40	30	56	0	100	0
10	70	0	30	33	30	30	40	57	0	90	10
				34	30	20	50	58	0	80	20
11	60	40	0	35	30	10	60	59	0	70	30
12	60	30	10	36	30	0	70	60	0	60	40
13	60	20	20					61	0	50	50
14	60	10	30	37	20	80	0	62	0	40	60
15	60	0	40	38	20	70	10	63	0	30	70
				39	20	60	20	64	0	20	80
16	50	50	0	40	20	50	30	65	0	10	90
17	50	40	10	41	20	40	40	66	0	0	100
18	50	30	20	42	20	30	50				
19	50	20	30	43	20	20	60				
20	50	10	40	44	20	10	70				
21	50	0	50	45	20	0	80				

parallel to *B-C*, each of these lines will represent a step of 10% of constituent "A." For example, the point *X* which is located on the 50 line will refer to 50% of "A." It must be remembered that any position on this line will represent 50% of this material.

In Triangle II the same arrangement is shown for constituent "B," and it will be noted that the distance between apex *B* and base-line *A-C* is divided into ten equal parts and the point *X* represents 30% of constituent "B." This also applies to Triangle III which shows the composition for constituent "X" which falls on the 20 line.

Superimposing Triangles I and II on III gives the sub-division as shown in Triangle IV, from which the composition of point *X* can be readily determined. Since all three constituents must always total 100%, it is only necessary to determine the percentage of any two of the constituents and obtain the third by difference.

It will be noted that each intersection of Figs. 2 to 8, inclusive, is numbered and that these numbers represent the various mixtures employed. Apex 1 represents 100% of coarse flint clay. Apex 56 represents 100% of medium-sized flint clay; while at 66, 100% of fine material is represented. Each of the other numbers refers to a mixture of two or three of the particle sizes, and the composition thereof can be readily determined from the figures or, for convenience, from Table I.

All the clays used were ground at firebrick plants in dry pans. The flint clays were later screened in the laboratory. No screening was necessary for the plastic clays. The coarse flint clay particles used passed through a 4-mesh screen and were retained on a 12-mesh; the medium-sized passed 12-mesh and were retained on 20-mesh, while the fine size passed a 20-mesh screen. The average size of the coarse and medium grains was in the ratio of 1:0.365, as compared to the 1:0.414 ratio found

TABLE II

SCREEN ANALYSES OF THE CLAYS AS RECEIVED FROM THE PLANTS

Screen No. (meshes/inch)	Flint clays* (%)			Plastic clays† (%)	
	A	B	C	P	M
On 4	0.0	0.0	0.0		
" 8	9.5	10.5	15.2		
" 12	25.8	19.2	16.4		
" 16	15.3	12.9	13.7		
" 20	6.7	10.4	5.7	0.1	
" 30	12.7	13.5	13.1	0.3	0.1
" 40	5.8	6.3	4.1	1.2	2.9
" 60	7.5	8.0	9.1	7.5	10.6
" 80	4.2	2.7	4.3	5.5	5.9
" 100	2.1	2.6	2.0	6.5	6.2
" 160	2.5	3.2	3.9	9.8	10.4
Through 160	7.9	10.7	12.5	69.1	63.9
Total	100.0	100.0	100.0	100.0	100.0
Amount of coarse size in grind	35.3	29.7	31.6		
Amount of medium size in grind	22.0	23.3	19.4		
Amount of fine size in grind	42.7	47.0	49.0	100.0	100.0
Mix No. on triaxial diagram	Between 26 and 34	Between 33 and 34	34		

* Clays A, B, and P are from Pennsylvania.
† Clays C and M are from Missouri.

by Taylor and Thompson[4] for spheres; while the average size of the fine material was much smaller than the 1:0.222 ratio.

Table II presents the screen analysis of the flint and plastic clays as received from the plants. It also shows the percentage of the coarse, medium, and fine particles present in each of the flint clays for the three commercial grinds and their approximate mix number on the triaxial diagram.

The chemical analyses and the P.C.E. value of the clays are given in Table III. For reasons which are explained later, two of the flint clays, A and B, were from Pennsylvania and one, C, was from Missouri. A plastic clay from each district was used for bonding the flint-clay mixtures.

(1) Pilot Test (Series A) The necessary amount of each of the three sizes of flint clay was weighed out with the plastic clay, and these were shaken in a large bottle to secure a thorough mixing. Water was then added carefully until the consistency was suitable for molding. Three $1^1/_2$-inch cubes were made by hand from each batch. The amount of water added was determined from the wet and dry weights, and the volume of each cube when dry was determined from the saturated and suspended weights taken in kerosene. After carefully distilling off the kerosene, the cubes were ready for the first firing.

In the first series of experiments, designated as Series A, $12^1/_2\%$ of the plastic clay, P, was added to the various mixes of Pennsylvania flint clay, A.

TABLE III

CHEMICAL ANALYSES AND P.C.E. VALUES OF THE CLAYS

	Flint clays* (%)			Plastic clays† (%)	
	A	B	C	P	M
Ignition	13.52	13.56	12.44	11.00	12.40
Silica	43.10	43.73	28.42	52.00	52.60
Alumina	38.94	39.18	53.04	30.21	28.73
Ferric oxide	1.74	0.66	1.16	2.25	2.49
Titania	2.80	2.11	2.58	2.30	1.40
Lime	0.16	0.22	0.37	0.07	0.71
Magnesia	0.08	0.08	0.35	0.13	0.57
Alkalis	0.19	0.21	1.60	2.00	0.59
	100.53	99.75	99.96	99.96	99.49
P.C.E.	33–34	33–34	35	31	31

* Clays A, B, and P are from Pennsylvania.
† Clays C and M are from Missouri.

The percentage of plastic clay was purposely kept low to prevent masking the effects of proportioning the flint-clay particle size.

The volume change on drying was unusual. There was a relatively large expansion in some of the coarser mixes having a low water content, whereas the finer mixes with higher water content had the usual shrinkage. Evidently, the small amount of plastic clay present could not develop a bond sufficient to hold the flint-clay grains together under the strains set up in the drying.

The cubes were fired in a laboratory kiln, the schedule being to raise the temperature to 1290°C in 4 hours and to maintain this temperature for 3 hours, bringing down cone 13. After determining the porosity and volume change for this firing, the cubes were then heated in 4 hours to 1400°C and held for 5 hours. Their properties were determined again and they were then given a third firing to 1500°C for 5 hours.

The volume changes for the 1400°C and 1500°C firings were calculated on the basis of the volume after the 1290°C firing.

In general, the results of the volume change, due to firing, are of little value in this study because of the secondary expansion which took place in this flint clay, off-setting the effects brought out through the proportioning of particle sizes. This expansion occurred in a number of mixes in the 1290°C firing and was more evident in the 1400°C and 1500°C firings. It is of interest to note that the coarsest mixes expanded the most, and that as the finer mixes were approached, the expansion decreased to zero and changed to a normal shrinkage.

In view of this condition, it was decided to secure a second Pennsylvania flint clay which would not show the secondary expansion and then to conduct a second series in which a number of refinements could be introduced. The second sample of flint clay is listed in Tables II and III as sample B.

(2) Improved Procedure Hand molding the cubes was replaced by pressure molding, and for this purpose a special press was constructed. In this press each cube was formed at a pressure of 310 pounds per square inch by means of a calibrated spring.

Trials were made of a number of the mixes shown on the diagrams, varying the water content to obtain the amount proper for press molding. By interpolation a diagram was made showing the amount of water to be used in each mix.

Water was added to the mixes from a burette. The mud was carefully worked up by hand, wrapped in wax paper, and placed in a damp closet for about 18 hours. After molding, the test pieces were allowed to air-dry and later they were dried at 115°C.

Some difficulty was experienced in the pilot tests (series A) in obtaining consistent results, owing to the loss of particles from the edges or corners of the coarser mixes. For this reason, it was decided to determine changes in dimensions during firing both by volumetric and by linear methods. The volumes were determined by the displacement of liquids, while the linear measurements were made between parallel disks $^3/_4$ inch in diameter with an Ames dial. Each cube was measured for its three dimensions to the closest one-thousandth inch.

A clay which shows a secondary expansion will exhibit this property to a maximum degree when fired in small laboratory kilns because of the atmosphere and the fast rate of heating. The slower firing of plant kilns often brings out this characteristic, but to a smaller degree. Other firing characteristics are also found to be different when comparing laboratory and plant firings, and for all these reasons, the test pieces were put through a plant tunnel kiln which brings down cone 12.

III. Series B

(1) Mixes Three distinct series of mixes were made up for series "B" to study the effect of increasing the percentage of plastic clay.

In series B-1, 12½% plastic clay, P, was added to the various mixtures of particle sizes. Previous work showed that the mixes in the coarse end of the diagram could not be made up satisfactorily with as little plas-

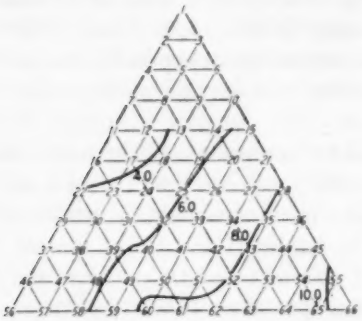

FIG. 2.—Series B-1. Volume firing shrinkage by linear measurement.

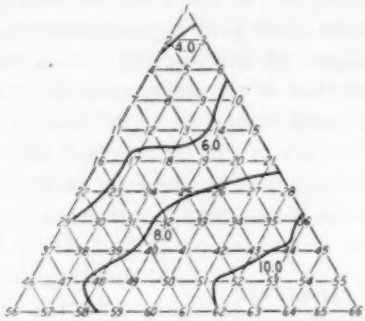

FIG. 3.—Series B-2. Volume firing shrinkage by linear measurement.

tic clay as 12½%, and therefore only those mixes containing less than 70% of coarse flint clay were included.

In place of changing the proportion of grain sizes in steps of 10%, it was decided to use intervals of 20%.

In series B-2, 20% of plastic clay was used in each mix, the flint clay being varied in steps of 10%.

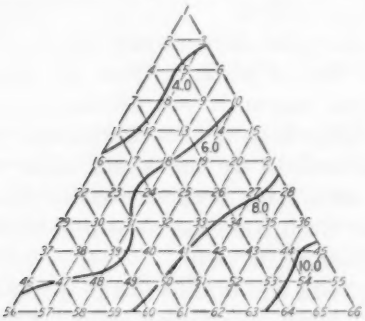

FIG. 4.—Series B-4. Volume firing shrinkage by linear measurement.

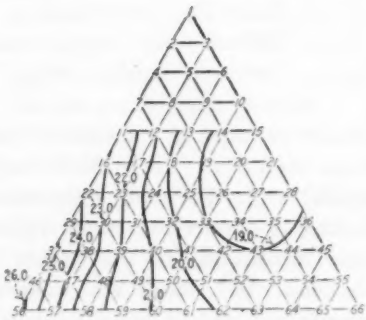

FIG. 5.—Series B-1. Porosity of fired bodies.

Series B-3 was made up with 30% of plastic clay covering the mixes in the diagram, using steps of 20%.

Some of the data are shown in Figs. 2 to 7, inclusive.

(1)Bulk Density The bulk density was determined on the unfired and fired cubes by the displacement of kerosene and water, respectively. These data are not of sufficient interest to be given here, although they did bring out two points that are worthy of mention.

Series B-1 showed that an appreciable difference in bulk density resulted from grading the particle sizes. This was less noticeable in series B-2 and B-3, owing in part to the higher content of plastic clay, which was added fine material.

Another point is that the order of the bulk density may change completely when the mixes are fired, and more pronouncedly as the percentage of plastic clay increases. For this reason, bulk density figures on unfired clay ware cannot be used as an index to their probable density when fired.[12]

(2) Firing Shrinkage Data are given graphically in Figs. 2, 3, and 4 for volume shrinkage as determined by linear measurements. It is believed that the shrinkage calculated from the linear measurements are more accurate because of the loss of corners and edges

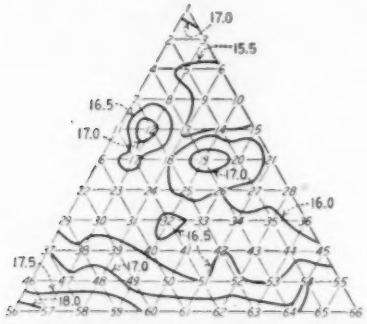

FIG. 6.—Series B-2. Porosity of fired bodies.

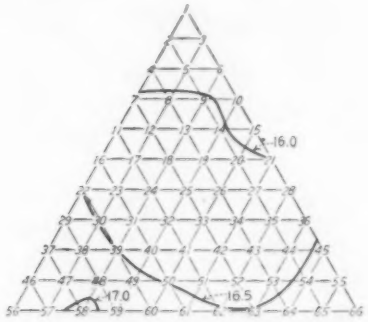

FIG. 7.—Series B-3. Porosity of fired bodies.

of some of the mixes, particularly those of series B-1 and the coarser mixes of series B-2 and B-3.

The diagrams indicate that there is relatively a small difference in firing shrinkage resulting from increasing the plastic clay from $12^1/_2$ to 20% and 30%. All the diagrams show, however, that the mixes radiating from the fine corner decrease in firing shrinkage.

The volume shrinkage data vary proportionally with the amounts of water added for pressing; in fact, the one depends upon the other. It appears, however, to be more nearly correct to say that both vary in the same ratio with the fineness of the mixture.

(3) Porosity The porosity data are presented in graphic form in Figs. 5, 6, and 7.

Series B-1 shows that considerable difference in porosity may be ob-

[12] EDITOR'S NOTE: The bulk density of unfired masses consisting largely of such nonplastics as mullite and silicon carbide (not silica), magnesite, and chrome is frequently used to anticipate their density when fired.

tained by the proportioning of flint-clay particles when the percentages of plastic clay are low. Figures 6 and 7 show that when 20% and 30% of bond clay is added the effect of varying the proportion of flint-clay particles is lost.

Denser mixes are obtained by using the higher percentages of plastic clay. The densest mixes in series B-1 are higher in porosity than the most porous of those in series B-2 or B-3.

IV. Series C

The B-series was conducted on the two Pennsylvania clays. Series C is a duplication of series B, using Missouri flint and plastic clays.

The flint clay obtained was supposed to represent a true Missouri

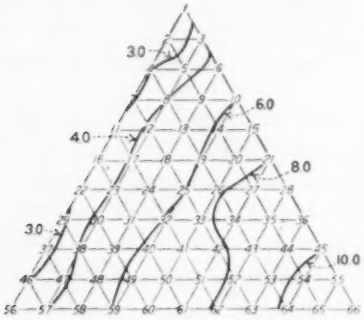

FIG. 8.—Series C-3. Volume drying shrinkage.

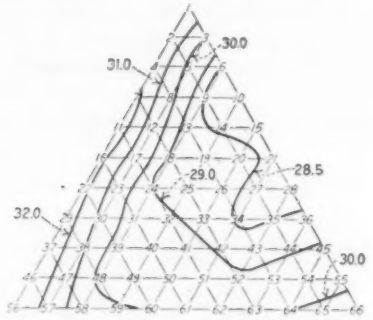

FIG. 9.—Series C-1. Porosity of fired mixes.

flint, but it will be noted that this material (flint clay C, Table III) is high in alumina, indicating that considerable burley or diaspore was included.

Plastic clay M is comparable in composition with the Pennsylvania plastic except that the alkalis are appreciably lower. These clays were obtained from the regular plant ground stock.

The procedure followed was the same as that of the former series, although some improvements in minor details were made. For example, upon adding water to the trial mixes in each series, several batches were prepared and water was added to each of these so that they would range in consistency from being too dry to those which were too wet. In this manner, the optimum amount of water was determined and the extra work involved proved worth while from the improved consistency of the data in each series.

The cubes were fired in the same tunnel kiln as that used for the B-series, bringing down cone 12. Some of the data obtained on series C-1, C-2, and C-3 are presented in Figs. 8 to 12, inclusive.

(1) Results Obtained In general, the data of this series are the same as those of series B.

The most consistent set of porosity figures was obtained from C-1, shown in Fig. 9. The porosities obtained on C-2 and C-3 show smaller effects for grain-size control because of the higher percentages of plastic clay.

Figures 10, 11, and 12 show firing shrinkage data, and in each series this decreases as the percentage of fines is reduced. The order of the shrinkage increases from C-1 to C-3 which did not occur in series B.

V. Series C-4, C-5, and C-6

A series was made with certain mixes of Missouri and Pennsylvania clays. C-4 is Missouri flint and Pennsylvania plastic, C-5 is Pennsylvania

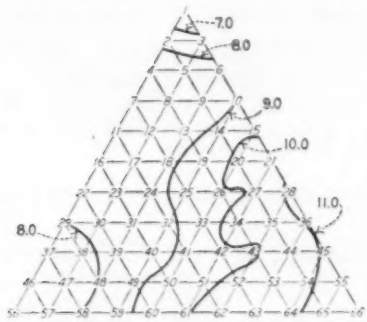

FIG. 10.—Series C-1. Volume firing shrinkage by linear measurement.

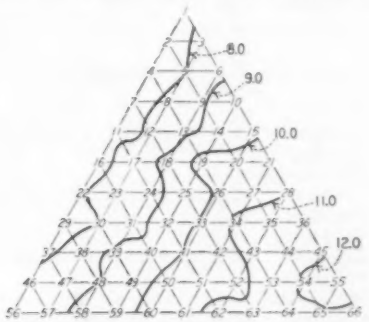

FIG. 11.—Series C-2. Volume firing shrinkage by linear measurement.

flint and Missouri plastic, and C-6 duplicates B-2 which is Pennsylvania flint and plastic.

Since 20% plastic was used in these mixes, series C-2 can be used for comparison (Missouri flint and plastic).

Mixes 1, 56, and 66 represent all coarse, all medium, and all fine flint clay. Mix 34 is typical of commercial grinds and was used for that reason. Mix 6 represents the mixture which gives the greatest density when the three sizes of flint-clay particles were mixed with 20% plastic clay, and mix 28 is the densest in the $12^1/_2\%$ series when fired.

Although complete data were obtained on these mixes, only the porosity and volume firing shrinkage from linear measurement are presented. These are given in Table IV.

The densest mixes are obtained in series C-6, Pennsylvania flint and Pennsylvania plastic; while the most porous bodies are those of C-2, Missouri flint and plastic.

Series C-4, Missouri flint and Pennsylvania plastic, is not as dense as the Pennsylvania flint and Missouri plastic of series C-5.

The firing shrinkage follows the order of the porosity figures with the exception that C-5 shrank less than C-6.

In general a greater difference is obtained in combining the clays from the two districts than that resulting from the flint-clay sizes represented by various mixes. More information would probably have been obtained if 12½% plastic had been used in place of 20%.

VI. Series D

A series based on satisfactory mixes for cement aggregates was made. The procedure used in this series was the same as that of series B so that comparisons could be made. Table V presents the particle-size composition of the mixes in series D as well as their composition expressed as the coarse, medium, and fine particle sizes used in the previous series.

TABLE IV

	Porosity (%)						Volume firing shrinkage (%) (from linear measurements)					
Mix No.	1	56	66	34	6	28	1	56	66	34	6	28
C-2 Series Mo. flint Mo. plastic	28.1	29.3	28.7	26.4	26.6	26.8	7.66	8.40	11.73	11.22	8.70	10.97
C-4 Series Mo. flint Pa. plastic	26.1	28.4	27.6	26.5	25.0	25.1	7.70	8.64	12.90	10.81	8.50	11.48
C-5 Series Pa. flint Mo. plastic	24.2	25.5	21.4	20.4	20.9	20.9	+0.44	3.12	7.87	5.14	1.53	5.17
C-6 Series Pa. flint Pa. plastic	20.5	23.6	19.6	18.8	17.7	18.3	2.05	4.41	10.50	7.02	3.04	6.76

Data for the porosity and firing shrinkage are also given to show the results obtained by experiment and those predicted by using the data obtained in series B-1, B-2, and B-3. For example, the porosity for mix D-1 as determined by experiment is 15.5% and the mix which most closely duplicates this in series B would indicate that the porosity should be 18%.

Although close comparisons cannot be made between series B and series D, it appears that denser mixes can be obtained by proportioning a large number of particle sizes than by using only three sizes. The percentage of plastic clay in the mixes of series D could account for the changes in porosity, although this could not be said with regard to the shrinkage figures.

VII. Series E

The porosity data obtained in series B shows that upon increasing the plastic clay added to proportioned flint-clay particles, the effects of grading are partially lost. The porosity figures of series B-1 show that with 12½% as a bond, there are notable results obtained and for this reason,

it was believed that experiments should be conducted to show the effects of proportioning flint clay when no plastic clay is included in the mix.

(1) Procedure Several methods for determining the bulk density of the flint-clay particles were tried before a satisfactory one was found. When mixtures of several sizes of particles are placed in a container and tapped or vibrated, segregation takes place and this is dependent upon the length of time of tapping and its intensity. For this reason, it was decided to tamp the mixture of particles into a container, filling it by small additions.

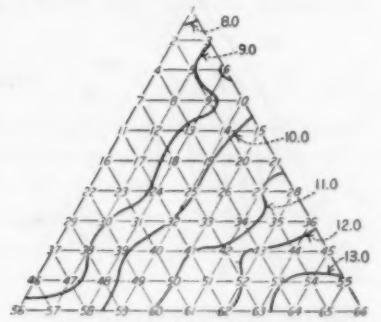

FIG. 12.—Series C-3. Volume firing shrinkage by linear measurement.

A cylindrical container $2^1/_4$ inches in diameter and $3^1/_2$ inches high

TABLE V

COMPOSITION AND PROPERTIES OF MIXES IN SERIES-D

Formula	Parabola	Parabola plus 5% extra plastic clay	Taylor and Thompson: Crushed stone and sand	Taylor and Thompson: Gravel and sand
Series designation	D-1 (%)	D-2 (%)	D-3 (%)	D-4 (%)
Flint clay on 8-mesh	29.1	27.8	35.5	37.0
" " " 12 "	16.4	15.6	14.5	14.0
" " " 16 "	8.6	8.2	6.3	7.5
" " " 20 "	3.8	3.6	2.4	2.7
" " " 30 "	9.4	8.9	4.8	6.0
" " " 40 "	4.3	4.0	2.0	2.5
" " " 60 "	5.5	5.3	4.8	5.5
" " " 80 "	3.6	3.4	3.7	5.5
" " "100 "	1.6	1.5	2.0	1.6
" " through 100				
Plastic clay through 100	17.7	21.7	24.0	17.7
Composition Based on Mixes in Triaxial Series				
Coarse flint clay	45.5	43.3	50.0	51.0
Medium flint clay	12.4	11.8	8.7	10.2
Fine flint clay	24.4	23.2	17.3	21.1
Plastic clay	17.7	21.7	24.0	17.7
Data on Fired Mixes				
Porosity by experiment (%)	15.5	14.6	14.1	15.9
Porosity by interpolation of series B (%)	18.0	16.5	15.6	16.6
Volume firing shrinkage by experiment (%)	5.82	5.36	5.36	5.37
Volume firing shrinkage by interpolation of series B (%)	5.5	5.6	5.8	5.8

was used. A 500-gram batch of the mix was thoroughly mixed and divided into ten equal parts. Each part was placed in the container and tamped before the next was added. When the container was heaping

full, the excess was removed by a straight edge and the bulk density of the clay determined from the weight of the clay and volume of the can. Three such determinations were made for each mix and the resulting determinations showed a variation of less than 0.1%. Determinations were made on all mixes of the diagram at intervals of 20%, except those mixes containing 0 and 10% of the medium material and for these, steps of 10% were used, since this field of the diagram is believed to be the most interesting.

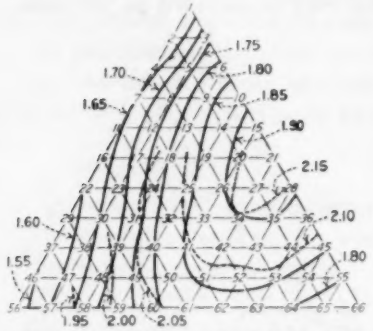

FIG. 13.—Bulk density data for series E compared with that of series B-1. (Solid lines represent series E; broken lines, series B-1.)

(2) Results Figure 13 presents the data for series E, together with bulk density data for series B-1, which are included for the sake of comparison.

TABLE VI

DATA FROM SERIES B AND C GIVING MAXIMUM AND MINIMUM VALUES FOR DIFFERENT PROPERTIES

Property	Series	Maximum value	Mix No.	Minimum value	Mix No.	Difference between values
Water added for molding (%)	B-1	11.3	66	6.4	11	4.9
	B-2	11.7	66	6.2	1	5.5
	B-3	12.7	66	8.0	1	4.7
	C-1	16.5	66	12.0	1	4.5
	C-2	16.5	66	12.5	1	4.0
	C-3	17.5	66	12.5	1	5.0
Bulk density of unfired body	B-1	2.17	15	1.94	56	0.23
	B-2	2.21	6	2.08	66	0.13
	B-3	2.19	1	2.04	66	0.15
	C-1	2.07	15	1.90	56	0.17
	C-2	2.07	3	2.00	66	0.07
	C-3	2.06	1	2.01	66	0.05
Porosity after firing (%)	B-1	26.2	56	18.3	15	7.9
	B-2	18.3	56	15.2	6	3.1
	B-3	17.1	58	15.9	6	1.2
	C-1	33.0	56	28.0	15	5.0
	C-2	29.3	56	26.3	36	3.0
	C-3	27.5	37	24.8	43	2.7
Volume firing shrinkage from linear measurements (%)	B-1	11.4	66	2.7	11	8.7
	B-2	11.4	66	3.3	1	8.1
	B-3	10.9	66	2.6	1	8.3
	C-1	12.0	66	6.0	1	6.0
	C-2	12.7	55	7.6	1	5.1
	C-3	13.8	66	7.7	1	6.1

It is apparent that both series are in close agreement, indicating that the $12^1/_2\%$ of plastic clay used in compounding series B-1 does not vitiate the result of proportioning particle sizes.

Table VI presents maximum and minimum values for the various proper-

ties of the mixes in series B and C. This table shows the order of the variation which may be expected in a given property, as well as the effects produced by changing the percentage of plastic clay used to bond the flint clay.

VII. Summary

(1) Density Maximum density in the unfired bodies is obtained when about equal parts of fine and coarse sizes are mixed, with little or no medium-sized material.

The mixes which contain $12^1/_2\%$ of plastic clay show essentially the same trend in density data for a given variation in grading as corresponding mixes without plastic clay.

The bulk density of unfired bodies is not necessarily an index to the density of the finished product, since the firing characteristics of the body must be taken into account.

(2) Shrinkage The shrinkage which takes place during firing can be varied over a fairly wide range by proportioning the particle sizes. The firing shrinkage increases as the percentage of fine material increases.

Increasing the plastic clay from $12^1/_2$ to 30% does not have as great an effect on the firing shrinkage as that obtained through proportioning the particle sizes.

(3) Porosity The porosity of a body can be varied over a fairly wide range, especially in those mixes low in plastic clay.

As the percentage of plastic clay is increased, benefits to be derived through proportioning grain size are decreased.

(4) Material Variations The data of Table IV show that greater differences may be expected through the combination of various types of clays over those obtained from proportioning the grain size of a particular combination.

The data of Table V indicate that greater benefits may be derived through the combination of a larger number of particle sizes than the three which were arbitrarily chosen for this study.

(5) Processing From the results obtained, it would seem that as far as density is concerned, there would be little gained in carefully proportioning grain size in those processes employing the hand-made or stiff-mud methods of manufacture. In the case of the dry-press process, this would not apply because of the lower plastic clay content of the mix used. It is quite likely that the higher pressures used in this process over those used in the study may show a wider range in the variation of properties as a result of the proportioning grain size.

(6) Texture Probably the greatest benefits to be derived from a more comprehensive study of the whole subject of proportioning

particle sizes are those which have to do with texture or structure of the body. The data presented do not indicate the wide range in texture which was covered by the various mixes. This work might well be continued by an investigation of the effect of structure in resisting spalling, slag penetration, resistance to loads, and other properties upon which depends life in service.

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A STUDY OF THE EFFECT OF GROG ON PRESSURE TRANSMISSION IN DRY PRESSING[1]

By C. M. Dodd[2] and M. E. Holmes[3]

ABSTRACT

A study of the dry-pressing characteristics of several fire brick and building brick clays was made by compressing them, at high and low pressures, into large shapes with a hydraulic press. The clays do not effectively transmit the pressure into the interior. The finest grained clays are more deficient in this respect. The result is a porosity gradient as high as 15% of the interior porosity between center and surface. Such a variation may account, in part, for the defects in dry-press ware. The addition of fired grog increases the pressure transmission. Some clays require more than 50% grog and some less for maximum pressure transmission and optimum results. Fireclay shapes as much as ten inches in thickness and of substantially uniform physical properties can be formed if the proper amount of grog is used.

I. Introduction

No aspect of dry pressing is more fundamental than pressure transmission. If the forming pressure is not effectively and uniformly transmitted from top to bottom, end to end, and side to side, the shape will be non-uniform in porosity, density, bond, strength, and shrinkage characteristics, the effects of which in the fired product may be relatively low strength, low resistance to spalling, low resistance to load at high temperatures, low resistance to slag action, shrinkage cracks, or warped or otherwise distorted shapes. In part it is this lack of adequate pressure transmission and its equality of distribution that limits the thickness and the complexity of shape of ware that can successfully be made by the dry-press process.

These considerations with a method of pressure transmission study were proposed in 1930 and the differences between several commercially-used clays and mixes in regard to pressure transmission were presented.[4] Some of the data indicated that grog might have an important effect. The results of the experiments with grog which followed, are presented in this report. The previous report had shown that even in mixes having poor pressure transmission characteristics, the horizontal distribution of pressure from end to end and side to side is good but that the most important inequalities that exist in pressure distribution are vertical, from top to bottom. More specifically, therefore, the study is on the vertical transmission of pressure as affected by grog.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received March 13, 1931.

[2] Associate Professor of Ceramic Engineering, Missouri School of Mines, Rolla, Mo.

[3] Professor of Ceramic Engineering, Missouri School of Mines, Rolla, Mo.

[4] National Brick Mfrs. Assn., *Bull.*, No. 109; also C. M. Dodd, G. A. Page, and F. F. Netzeband, "Study of Dry-Press Process," *Brick Clay Rec.*, **78** [6], 322 (1931).

II. Preparation of the Mixes

The clays (which cover practically the entire plasticity range used in dry pressing) and grog were ground in a 3-foot dry pan, having openings 1/8

TABLE I

SCREEN ANALYSES

Sieve	Grog	St. Louis surface clay 10-mesh	Cheltenham clay 8-mesh	North Missouri plastic clay 8-mesh	North Missouri semiflint clay 8-mesh
On 10	11.52	4.26	11.32	10.11	11.81
Through 10 on 14	11.88	11.08	11.49	12.29	11.89
14– 20	12.51	9.44	9.69	9.91	9.55
20– 28	14.92	10.51	12.00	12.05	11.30
28– 35	10.78	7.11	9.49	9.01	8.73
35– 48	8.35	5.03	8.04	7.33	7.49
48– 65	6.53	3.75	6.91	6.35	6.68
65–100	6.71	3.29	9.29	8.57	8.69
100–150	5.35	2.38	8.51	7.64	8.57
150–200	1.94	1.22	1.49	3.40	2.95
Through 200	9.45	41.98	11.79	13.89	12.49

by 5 inches, to fineness of 8- to 10-mesh. The preceding table gives an approximate screen analysis of each of the ground materials.

Details regarding the experimental procedure and the methods of tests are given in the above-mentioned references.

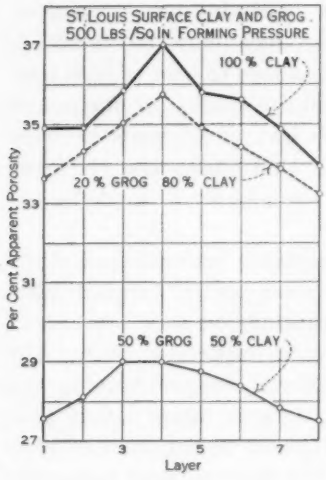

FIG. 1.

III. Results at 500 Pounds per Square Inch[5]

(1) St. Louis Surface Clay This clay when used without grog exhibits poor pressure transmission at 500 lb. per sq. in. (see Fig. 1). Maximum porosity develops in the middle or fourth layer from which point it slopes down steeply to much lower values for the top and bottom layers. This means that the pressure developed by the moving ram has been absorbed largely in the top and bottom portions of the block and that it has not been transmitted adequately into the interior. The block would be soft-cored or "shelly" and would be subjected to severe stresses in drying and firing.

The addition of 20% grog slightly alters the course of the curve but again there is a soft, inadequately compressed section in the region of the fourth layer. That the grog has contributed to the transmission of pressure into

[5] For methods of pressing, preparation of test pieces, and of testing see *Brick Clay Rec.*, **78** [6], 322 (1931).

the interior is indicated by a slight tendency of the curve to "flatten out," the maximum variation in porosity in this case being 2.4% compared with 3.3% when no grog is used.

With 50% grog, the maximum porosity variation is reduced to 1.5% and the short peaks in the curves for the lower grog contents are eliminated. It is assumed that intermediate amounts of grog would have intermediate effects and that a somewhat greater than 50% grog content would substantially flatten the curve indicating, in that case, that 100% pressure transmission is being approached. This assumption is strongly supported by the data which show that in the case of Cheltenham clay 50% and grog 50%, a practically flat curve was obtained.

NOTE: If the mix were replaced with water and the mold box made water tight, equal pressure would be developed in all parts. Furthermore, the replacement of the mix by two pieces of metal or other solid, each one-half the size of the mix column, would permit pressure to be developed at their junction practically equal to that at the surface of the ram heads. Pressure transmission in both of these cases would be practically perfect.

It is claimed that a frog could be imbedded in a dry-press clay mix and compressed at hundreds of pounds with no resulting injury, provided the mix column is sufficiently long.

The energy of compression may be absorbed as it is transmitted from grain to grain and if there are enough of these transmissions there may not be any compression at a distance from the ram heads. It would follow that the finer the grains of the clay, the less would be the pressure transmission. This clay, which is the finest included in the investigation, transmitted the poorest pressure. The effect of adding the comparatively coarse grog is to decrease the number of transmissions of energy and thereby to approach more nearly to the compression of a solid.

It was observed that with the higher grog contents, the convexity of the layers was reduced. This indicates that the grog reduces die friction. It is apparent that this would be the case when the grog content was high enough to develop spaces between the grog grains too large for the clay to fill completely. In that case, the number of contact points between the sides of the mold box and mix would be reduced and to that extent die friction would be reduced. This would eliminate another source of absorption of energy and permit a more nearly complete application of the compressing force to the compacting of the grains in the interior of the shape.

The marked reduction in average porosity which results from the addition of grog is without significance insofar as pressure transmission is concerned. The grog has a porosity of about 17%. Its addition to a clay which, without grog develops a different porosity, will yield results of intermediate value. In the case of the surface clay, which without grog gave an average porosity of about 35.5%, the intermediate value of 28.5% was obtained. Careful calculations, making allowance for the differences in specific gravities of the clay and grog, yield theoretical average porosities for the grogged mixes practically identical with the actual average porosities obtained. The shape of the curve, however, which is the real index of pressure transmissions, is another matter.

(2) North Missouri Plastic Fire Clay

This clay exhibits dry-pressing characteristics quite similar to those of the St. Louis surface clay (see Fig. 2). With no grog, most of the compression

takes place at the top and bottom of the block, the porosity of the center being about 3.5% greater than that of the bottom portion. Twenty per cent grog has a slight effect, reducing the porosity variation to 3.4%. The addition of 50% grog reduces the maximum porosity variation to 1.7% and the sharp peak of the curve is eliminated. The indications are that only slightly more than 50% grog would be required to transmit pressure equally into all parts of the block.

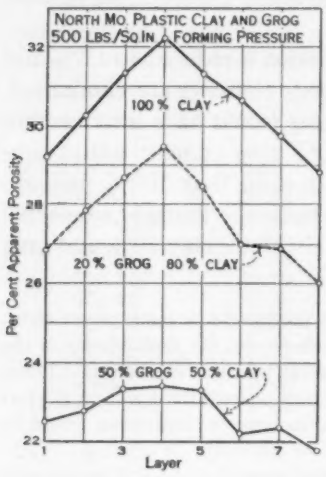

FIG. 2.

(3) Cheltenham Fire Clay

This clay exhibits somewhat better pressure transmission than the two clays already discussed (see Fig. 3). With no grog, the peak in the curve is not so sharp and the porosity variation is only 2.9%. Twenty per cent grog reduces this variation to 2.5% and 50% grog reduces it to 1%. The curve for the 50% grog mix is practically flat indicating nearly perfect pressure transmission. Doubtless, fireclay shapes as thick as 10 inches could be made of 50% mixtures of Cheltenham clay and grog at 500 lb. per sq. in. which should dry and fire without developing defects due to differential shrinkage. Fifty per cent grog is about the optimum for this clay whereas the two clays mentioned above would require somewhat more.

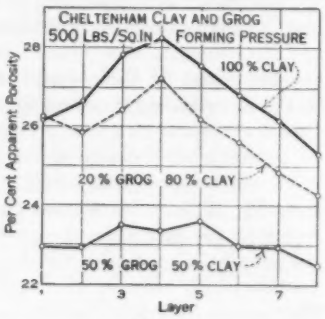

FIG. 3.

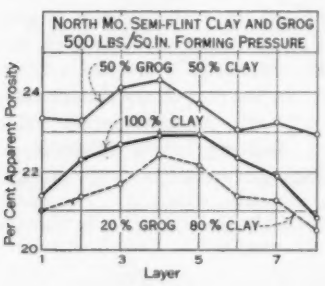

FIG. 4.

(4) North Missouri Semiflint Clay

This clay exhibits relatively good pressure transmission when used without grog (see Fig. 4). The maximum porosity variation is 2% and there is no steep porosity gradient from the center outward. This is perhaps due to the clay being naturally grogged. This clay has a higher percentage of very coarse grains when slaked, the effect of which is like that of fired grog. Although the clay was ground approximately to the same fineness as were the other clays,

tempering of the mix did not cause the coarse grains to slake as they did in the other clays.

Addition of the grog lowers the porosity as in the case of the other clays but this reduction does not continue up to the 50% grog content. With 50% grog the porosity is greater than with no grog. The explanation doubtless is that the clay, being naturally grogged, becomes over-grogged with 50% addition, thereby forming voids between the grog grains which are too large for the mass of clay present to fill.

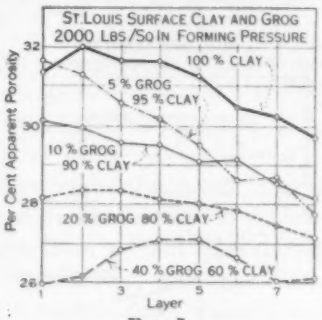

FIG. 5.

IV. Results Obtained at 2000 Pounds per Square Inch

A general comparison of the curves for 500 lb. per sq. in. with those for 2000 lb. per sq. in. shows that the increase from 500 to 2000 pounds results in shifting the point of maximum porosity from the center to the top of the block. The floating of the mold box at the higher pressures against a stationary upper ram by the moving lower ram probably accounts in full for this change.

Although increasing the pressure to 2000 pounds shifts the point of maximum porosity, it does not greatly increase the transmission of pressure and its distribution.

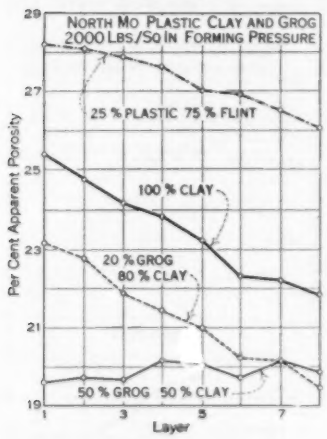

FIG. 6.

(1) St. Louis Surface Clay At 2000 pounds this clay responds progressively to grog additions showing a nearly uniform porosity with 40% grog (see Fig. 5). The only irregularity is the one for the top layer between the 0% and 5% grog content. This is probably due to an error in the determination for the top layer of the zero grog content. The maximum porosity variation decreased from 4.3% for the 5% grog content to 1.2% for the 40% grog content.

It is to be noted that at 2000 pounds compression 40% grog gave more nearly perfect transmission than did 50% at 500 pounds compression. This is doubtless due to the higher pressure bringing the grog grains closer together, thereby making a smaller grog content equally effective in establishing the mechanical contact between the grains required for pressure transmission.

It is apparent from these data that the addition of brick bat grog, even in

small amounts, will improve the quality of the product, but amounts ranging up to 40 or 50%, depending on the pressure employed, will be required for perfect pressure transmission and a physically perfect product.

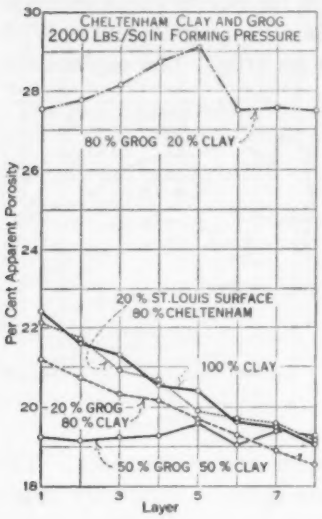

FIG. 7.

(2) North Missouri Plastic Fire Clay By increasing the grog content to 50% the maximum porosity variation is reduced from 3.5 to 0.8% (see Fig. 6). The indications are that fireclay shapes of large size could be successfully made under these conditions. It is noteworthy that whereas 50% grog was hardly adequate when compressed at 500 pounds it is a near optimum when compressed at 2000 pounds.

NOTE: The effect of adding 75% hard flint clay is noteworthy. It transmits pressure and tends to equalize the pressure but it is inferior in this respect to the fired grog. This brings up the question of the effect of the size and character of the grog, a subject which is now under investigation.

(3) Cheltenham Clay The superiority which this clay manifested over the North Missouri plastic clay at 500 pounds disappears at 2000 pounds in the 50% grog mixes (see Fig. 7). The indications are that it is more responsive to low grog contents when low pressures are employed.

NOTE: It is worth noting in passing that a small addition of fine-grained material such as the surface clay has no effect on pressure transmission whereas a coarse-grained material such as grog has an appreciable effect.

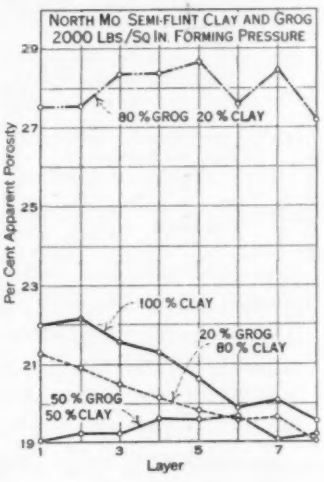

FIG. 8.

(4) North Missouri Semiflint Clay This clay yields a practically perfect block with 50% grog at 2000 pounds compression (see Fig. 8). In general the effect of the grog is much less and the effect of increasing the pressure is much greater than in the case of the plastic clay.

V. Summary

Representative firebrick and building-brick clays do not give good

pressure transmission. This is especially noticeable in large shapes, particularly those made of fine-grained clays where the interior porosity may vary from the surface porosity as much as 15% of the maximum porosity.

The effect of adding grog is to increase the pressure transmission. The degree of the effect varies with different clays, it being greater for the finer grained clays. Small additions of grog have positive effects but near 50% grog is required for the maximum effect.

The amount of grog required increases with a decrease in pressure and with an increase in the fineness of grain of the clay.

Clays such as semiflints which are naturally grogged require less added grog for equivalent pressure transmission.

The indications are that, with the use of a substantial amount of grog, large fireclay shapes as thick as 10 inches can be made of such uniform density that cracks and other defects which arise from differential shrinkage in drying and firing would be substantially eliminated. The indications are that the effect of grog addition is beneficial even in small amounts and in small shapes.

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THERMAL EXPANSION OF SILICA MORTARS AFTER FIRING AT 950°, 1200°, and 1500°C[1]

By Sandford S. Cole[2] and Don C. Lynn[3]

ABSTRACT

The thermal expansion between 20°C and 950°C of silica mortars after being fired at 950°, 1200°, and 1500°C was compared with the expansion of the materials before firing. The mortars showed marked difference in expansion behavior after being fired to 1500°C, indicating that there was developed a large amount of tridymite. The thermal expansion of the fired samples is less than that of the unfired samples.

I. Introduction

The study of the thermal expansion of silica mortars after being fired to several temperatures serves to complete the data on this subject. The literature survey previously made[4] showed a decided deficiency of information on the expansion of silica mortars. The effect of variations in clay content, grain size, and refractoriness of the mortar on the thermal expansion has been considered in this work. Travers and de Goloubinoff[5] have established that size of grain does not affect the expansion of silica brick while Heindl and Pendergast[6] report rather extraordinary expansion data on fire clays in which a considerable quantity of cristobalite was present. A silica mortar, being composed of quartzite, silica bats, and a siliceous clay, has in its raw state cristobalite, tridymite, quartz, and calcium silicate glass, as well as the minerals which may be present in the clay.

II. Scope of Investigation

The expansion behavior of a mortar fired to a predetermined temperature would be dependent to a rather large extent upon (1) the firing behavior of the clay, (2) the rate of reaction of the alumina of the clay with quartz, and (3) the rate of conversion of quartz to other forms.

The amount of alumina present in the clay would be expected to alter the expansion curves. Since the P.C.E. serves as a rather close index of the change in alumina content for mortars of similar grain size, the investigation of mortars of different P.C.E. was a logical procedure.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Revised copy received August 26, 1931.

[2] Industrial Fellow, The Koppers Research Corporation, Mellon Institute, Pittsburgh, Pa.

[3] The Koppers Research Corporation, Pittsburgh, Pa.

[4] Sandford S. Cole, "Thermal Expansion of Silica Brick and Mortars," *Jour. Amer. Ceram. Soc.*, **13** [7], 437–46 (1930).

[5] Travers and de Goloubinoff, "A Contribution to the Study of the Dilatometric Analysis of Silica," *Rev. Met.*, **23**, 27–47, 100–17 (1926).

[6] R. A. Heindl and W. L. Pendergast, "Fire Clays, Some Fundamental Properties at Several Temperatures," *Jour. Amer. Ceram. Soc.*, **13** [10], 725–30(1930); also Bur. Stand., *Jour. Research*, **5**, Research Paper, No. 194 (1930).

A series of commercial mortars of various grain size were also studied. Another series of mortars were compounded in the laboratory using an aggregate of graded sizes of silica bats and quartzite to which clay additions were made. This eliminated the unknown factors of amount of clay and established constant grain size. The mortars when compounded had screen analyses which were typical.

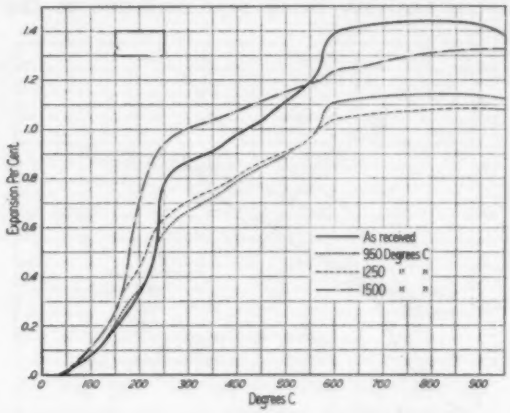

FIG. 1.—Sample No. 16780. P.C.E. 31–32. Plant C.

III. Materials Examined

The commercial mortars were supplied by four plants. Regular silica mortar for coke-oven construction is normally ground to pass a 20-mesh Tyler screen and usually passes a 28-mesh Tyler screen, with at least 35% passing 200-mesh. These mortars consisted of silica bats, quartzite, and a siliceous clay (approximately 70 to 75% SiO_2) from central Pennsylvania. The mortars are so compounded as to have a P.C.E. of cone 28 or more. This yields a mortar analyzing usually over 92% SiO_2 on calcined basis. The ideal mortar is one which will show no appreciable change in length on being fired to any temperature up to 1500°C and of such grain size as to have good working consistency.

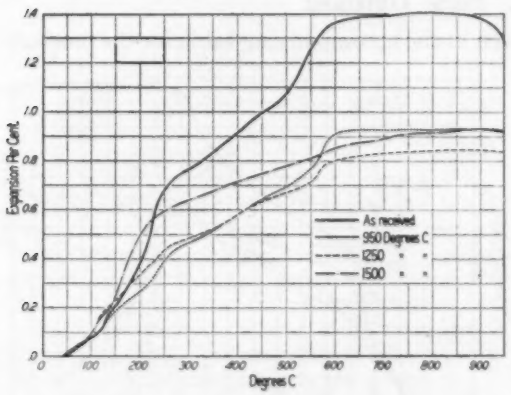

FIG. 2.—Sample No. 16622. P.C.E. 28–29. Plant A.

IV. Method Employed

The apparatus and the test bars were the same as before described.[4] The bars after heating at 950°, 1200°, and 1500°C for two hours were tested at the same temperatures as previously, *i.e.*, 70°, 90°, 110°, 120°, 140°, 160°, 170°, 190°, 200°, 220°, 240°, 260°, 280°, 300°, 350°, 400°, 450°, 500°, 540°, 550°, 560°, 570°, 580°, 600°, 650°, 700°, 750°, 800°, 850°, 900°, 950°C.

V. Samples Examined

The samples were separated; first, into four groups with respect to screen analysis, being representative of the plants producing mortars; second, a series in which the screen analysis was constant but the P.C.E. varied, from one plant; and third, the laboratory prepared samples.

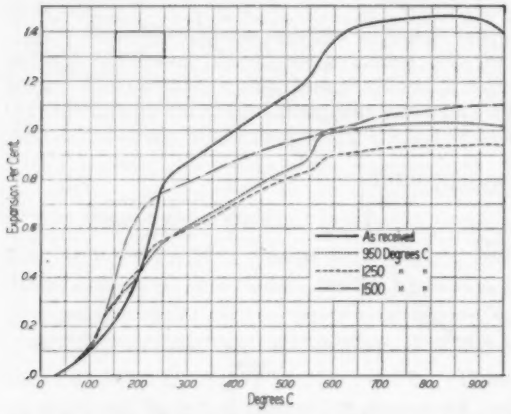

FIG. 3.—Sample No. 16790. P.C.E. 30-31. Plant B.

Samples 16780, 16662, 16534, and 18105 had 10 to 15% retained on 48-mesh screen and 35 to 40% through 200-mesh screen.

Samples 16790, 16622, and 16810 had 15 to 20% retained on 48-mesh screen and 35 to 40% through 200-mesh screen.

Samples 16536, 16497, and 16795 had 20 to 30% retained on 48-mesh screen and 35 to 40% through 200-mesh screen.

Samples 22645, 23184, 23247, 23190, 23233, and 22579 had 15 to 20% retained on 48-mesh screen and 45, 39, 39, 36, 36, 36%, respectively, through 200-mesh screen.

VI. Data Obtained

The per cent expansion is given in the accompanying table for the mortars at 100°, 200°, 300°, 500°, 600°, and 950°C. A few typical curves show the general nature of the expansion behavior of the mortars after firing to the several temperatures.

VII. Discussion

The thermal expansion data on silica mortars aids in measuring the rate of reaction of the alumina of the clay with the free silica when heated to elevated temperatures.

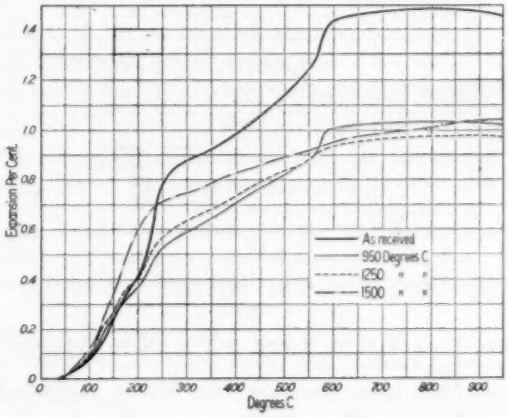

FIG. 4.—Sample No. 16795. P.C.E. 31. Plant D.

Heating of quartz and clay together will alter their physical states by forming other minerals and glasses which exhibit marked differences in

expansion behavior from the original materials. The heating of a mortar to 950°C, which causes but slight strength to be imparted to the clay, materially alters mortar expansion characteristics. The expansion at 575°C due to quartz is decreased and expansion of the mortars to 300°C is less.

The firing of the mortars to 1200°C has decreased the amount of free quartz as may be noted from the anomaly exhibited at 575 to 600°C. The alumina in the clay has to some extent altered the quartz and probably some of the free quartz has been taken into solution. The amount of expansion occurring at 200°C is greater with the 1200°C samples than 950°C samples. The curves for the clay (Fig. 5) show this quite distinctly.

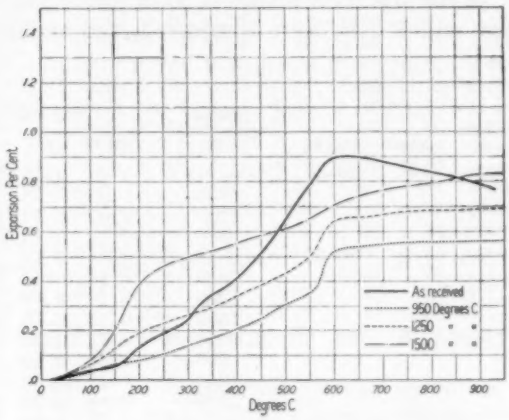

FIG. 5.—Sample No. 15069. P.C.E. 30–31. 100% clay.

The most distinct change in expansion behavior is for the samples fired at 1500°C. The amount of tridymite and cristobalite has decidedly increased and the quartz is practically converted to other forms. In case of the mortars made at plant C, where Baraboo quartzite is employed, there is less quartz conversion, but this could be expected since Baraboo quartzite converts rather slowly. Heindl and Pendergast[6] reported a considerable quantity of cristobalite in the siliceous clays after firing at 1400°C but no mention of tridymite was made. From these expansion curves, it would seem probable that there is present considerable quantity of tridymite after firing to 1500°C. Specific gravity

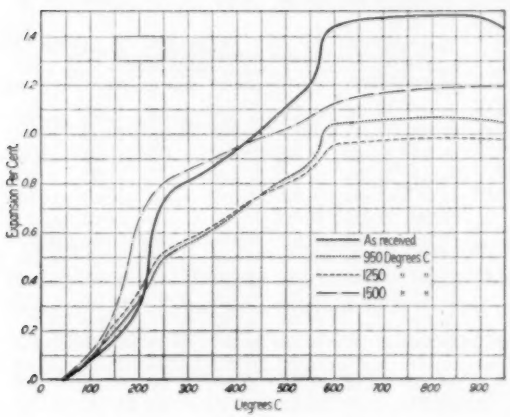

FIG. 6.—Sample No. 15069–2. P.C.E. 30–31. 25% clay.

data on silica mortars fired at various temperatures show at 1000°C, 2.50; at 1200°C, 2.44; and at 1500°C, 2.33; as compared with 2.55 as received.

In the first three groups of silica mortars in which the variation of screen size and P.C.E. were considered, the amount of clay present, or more

TABLE I

Sample No.	Plant	P.C.E.	Firing temperature (C)	Per cent thermal expansion from 20°C to						
				100°C	200°C	300°C	500°C	600°C	800°C	950°C
18105	C	29–30	As received	0.08	0.35	0.89	1.16	1.44	1.46	1.38
			950	0.08	0.28	0.52	0.73	0.92	0.95	0.94
			1200	0.09	0.40	0.62	0.82	0.94	0.98	1.00
			1500	0.15	0.75	0.95	1.11	1.19	1.25	1.28
16534	B	30–31	As received	0.08	0.42	0.87	1.18	1.41	1.46	1.45
			950	0.13	0.44	0.66	0.88	1.01	1.04	1.02
			1200	0.12	0.48	0.66	0.85	0.94	0.99	0.99
			1500	0.12	0.75	0.90	1.05	1.13	1.19	1.22
16562	B	31	As received	0.11	0.50	0.95	1.18	1.36	1.41	1.32
			950	0.07	0.40	0.80	1.05	1.27	1.29	1.29
			1200	0.11	0.50	0.68	0.86	0.97	1.02	1.02
			1500	0.14	0.72	0.89	1.02	1.09	1.15	1.17
16780	C	31–32	As received	0.08	0.33	0.87	1.11	1.39	1.44	1.38
			950	0.09	0.35	0.67	0.90	1.11	1.14	1.12
			1200	0.10	0.45	0.71	0.91	1.04	1.08	1.08
			1500	0.11	0.71	1.00	1.15	1.24	1.31	1.33
16622	A	28-29	As received	0.08	0.40	0.77	1.08	1.36	1.40	1.25
			950	0.08	0.27	0.46	0.67	0.91	0.92	0.91
			1200	0.10	0.34	0.48	0.69	0.80	0.84	0.84
			1500	0.10	0.51	0.64	0.78	0.85	0.91	0.91
16790	B	30–31	As received	0.10	0.40	0.86	1.13	1.36	1.46	1.39
			950	0.11	0.40	0.60	0.83	0.98	1.02	1.01
			1200	0.11	0.43	0.59	0.80	0.89	0.93	0.93
			1500	0.11	0.65	0.78	0.94	1.00	1.07	1.09
16810	A	31–32	As received	0.07	0.38	0.79	1.10	1.39	1.46	1.38
			950	0.06	0.35	0.57	0.82	0.98	1.00	1.00
			1200	0.08	0.43	0.64	0.88	1.00	1.03	1.03
			1500	0.14	0.70	0.94	1.08	1.15	1.20	1.23
16795	D	31	As received	0.07	0.40	0.87	1.14	1.43	1.48	1.46
			950	0.08	0.36	0.59	0.82	1.00	1.03	1.02
			1200	0.10	0.40	0.63	0.83	0.93	0.97	0.97
			1500	0.11	0.59	0.74	0.89	0.95	1.01	1.04
16536	D	31	As received	0.07	0.40	0.94	1.22	1.47	1.52	1.44
			950	0.10	0.36	0.58	0.80	0.95	0.98	0.97
			1200	0.09	0.42	0.64	0.82	0.91	0.96	0.96
			1500	0.09	0.60	0.74	0.90	0.96	1.01	1.02
16497	D	31	As received	0.07	0.40	0.70	0.99	1.27	1.31	1.28
			950	0.10	0.39	0.59	0.81	0.96	0.99	0.98
			1200	0.11	0.43	0.63	0.85	0.95	1.00	1.00
			1500	0.15	0.69	0.88	1.02	1.09	1.16	1.17
22645	A	28	As received	0.09	0.41	0.86	1.12	1.26	1.28	1.23
			950	0.09	0.36	0.56	0.76	0.90	0.93	0.91
			1200	0.09	0.33	0.49	0.66	0.77	0.80	0.81
			1500	0.11	0.49	0.61	0.76	0.83	0.91	0.93
23184	A	28–29	As received	0.08	0.40	0.76	1.00	1.22	1.25	1.24
			950	0.08	0.27	0.59	0.80	0.93	0.98	0.93
			1200	0.10	0.27	0.54	0.73	0.83	0.87	0.87
			1500	0.13	0.64	0.76	0.90	0.98	1.05	1.09

TABLE I (*Continued*)

Sample No.	Plant	P.C.E.	Firing temperature (°C)	Per cent thermal expansion from 20°C to 100°C	200°C	300°C	500°C	600°C	800°C	950°C
23247	A	29	As received	0.09	0.36	0.75	0.98	1.19	1.23	1.16
			950	0.10	0.40	0.63	0.84	0.98	1.01	0.99
			1200	0.11	0.40	0.59	0.78	0.87	0.93	0.93
			1500	0.12	0.62	0.75	0.91	0.99	1.06	1.09
23190	A	30–31	As received	0.09	0.42	0.91	1.20	1.45	1.49	1.40
			950	0.09	0.38	0.63	0.84	1.00	1.03	1.00
			1200	0.09	0.34	0.52	0.70	0.80	0.84	0.84
			1500	0.09	0.55	0.68	0.84	0.91	0.97	1.00
23233	A	31	As received	0.10	0.45	0.92	1.16	1.37	1.41	1.33
			950	0.09	0.43	0.68	0.90	1.04	1.07	1.05
			1200	0.08	0.40	0.60	0.79	0.89	0.92	0.92
			1500	0.11	0.57	0.66	0.79	0.87	0.93	0.97
22579	A	31–32	As received	0.11	0.49	0.95	1.21	1.46	1.48	1.41
			950	0.11	0.43	0.63	0.88	1.01	1.05	1.03
			1200	0.11	0.42	0.66	0.81	0.90	0.95	0.95
			1500	0.11	0.61	0.75	0.89	0.97	1.04	1.06

Sample No.	Description	P.C.E.	Firing temperature (°C)	Per cent thermal expansion from 20°C to 100°C	200°C	300°C	500°C	600°C	800°C	950°C
15069	100% siliceous clay	30–31	As received	0.03	0.12	0.24	0.64	0.89	0.84	0.75
			950	0.03	0.08	0.14	0.30	0.52	0.56	0.56
			1200	0.06	0.19	0.26	0.43	0.64	0.68	0.69
			1500	0.07	0.38	0.50	0.61	0.70	0.79	0.83
15069–1	22.5% clay mix	30–31	As received	0.08	0.27	0.83	1.12	1.49	1.50	1.49
			950	0.10	0.34	0.58	0.83	1.07	1.09	1.09
			1200	0.10	0.40	0.64	0.85	1.01	1.04	1.04
			1500	0.13	0.65	0.91	1.05	1.14	1.20	1.20
15069–2	25% clay lab. mix	30–31	As received	0.07	0.29	0.81	1.10	1.43	1.48	1.43
			950	0.08	0.32	0.55	0.81	1.03	1.06	1.04
			1200	0.08	0.35	0.57	0.79	0.95	0.98	0.98
			1500	0.10	0.65	0.85	1.01	1.12	1.18	1.19
15069–3	27.5% clay lab. mix	30–31	As received	0.06	0.32	0.75	1.05	1.37	1.41	1.39
			950	0.07	0.28	0.42	0.75	0.99	1.01	1.00
			1200	0.08	0.36	0.51	0.81	0.97	1.00	1.00
			1500	0.13	0.69	0.88	1.04	1.14	1.20	1.21
15069–4	30% clay lab. mix	28–29	As received	0.06	0.29	0.70	0.98	1.34	1.38	1.35
			950	0.09	0.31	0.48	0.74	0.97	1.00	0.99
			1200	0.08	0.33	0.55	0.76	0.93	0.96	0.96
			1500	0.15	0.71	0.92	1.08	1.18	1.24	1.26

specifically the P.C.E., has greater effect on the nature of the curves than the grain size. In case of low P.C.E. mortars, 16622 (Fig. 2) and 22645, the resulting data are quite comparable. The cause of this lower expansion is no doubt due to the presence of higher amounts of alumina forming more glass which has less expansion.

The data are of value only for comparative purposes since the mortars were fired for only two hours and it would be difficult to prognosticate what the expansion would be after long service. Since silica brick after several years of use show decided changes in mineral structure, it would be expected that silica mortars would exhibit similar behavior. When mortars are in service the temperatures may equal and exceed 1500°C in certain zones of refractory structures.

Several interesting facts may be noted from the curves, *i.e.:*

(1) After firing to the several temperatures, the thermal expansion at 800°C was less than for the unfired mortars.

(2) Up to 200°C, the rate of expansion for mortars unfired and fired to 950° and to 1200°C is about the same and above 200°C the expansion after firing to 1200°C is generally less than after firing to 950°C.

(3) The firing of mortars at 1500°C alters quite decidedly the expansion characteristics.

(4) The amount of expansion to 800°C is greater after firing at 1500°C than when fired to 950° and 1200°C.

(5) Finely-ground mortars of low P.C.E. value (probably of higher clay content) generally had less expansion at 800°C than other mortars.

(6) A series of mortars prepared in the laboratory (15069–1, 2, 3, 4) having nearly identical grain size and varying clay content had approximately the same amount of expansion at 800°C after firing at the same temperature.

(7) The expansion of the mortars, after being fired to temperatures which cause a partial or complete vitrification of a clay, is similar to that of silica brick.

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THERMAL SHOCK EFFECT ON THE TRANSVERSE STRENGTH OF CLAY BODIES[1]

By W. R. Morgan

ABSTRACT

Test specimens of twenty commercial shale and fireclay bodies, ranging in softening point from cones 7 to 30, were fired in laboratory kilns to cones 04, 2, and 6. Comparisons of transverse strength before and after thermal shock were made, thermal shock having been produced by eight cycles of heating in a furnace at 1100°F for 15 minutes and cooling over an air blast for an equal length of time.

Results indicate that as initial strength increases, per cent reduction in strength increases and strength after thermal shock increases to a maximum and then declines. Curves are fitted to the data and the mathematical relationships are shown.

The results of other investigators are discussed.

I. Introduction

Prior to 1927, published data on the effect of thermal shock on clay bodies was confined to the results of water- and air-quenching tests in which the basis of comparison was the number of quenchings required to produce failure.

Since that time data concerning thermal shock have been published by Goodrich[2] with relation to the compressive strength of fire brick; by Parmelee and Westman[3] with reference to the transverse strength of fire brick; by Heindl and Mong,[4] correlating transverse strength and other physical properties with quenching tests on sagger bodies; and by Heindl and Pendergast,[5] correlating transverse strength and other physical properties with quenching tests on fire brick.

The present study was undertaken primarily for the purpose of developing a method for making comparisons of the resistance of bodies to thermal shock on a quantitative basis and of establishing relations between physical properties and resistance to thermal shock by means of which resistant bodies could be designed and plant control of their manufacture effected.

The purposes of this paper are as follows:

(1) To describe the method briefly, presenting only sufficient data to indicate, in part mathematically, the general relation between transverse strength and resistance to thermal shock.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received March 7, 1931.

[2] J. R. Goodrich, "Spalling and Loss in Compressive Strength of Fire Brick," *Jour. Amer. Ceram. Soc.*, **10** [10], 784–94 (1927).

[3] C. W. Parmelee and A. E. R. Westman, "Effect of Thermal Shock on Transverse Strength of Fireclay Brick," *ibid.*, **11** [12], 884–95 (1928).

[4] R. A. Heindl and L. E. Mong, "V. Progress Report on Investigation of Sagger Clays and Preparation of Experimental Sagger Bodies According to Fundamental Properties," *ibid.*, **12** [7], 457–80 (1929).

[5] R. A. Heindl and W. L. Pendergast, "VI. Progress Report on Investigation of Fireclay Brick and the Clays Used in Their Preparation," *ibid.*, **12** [10], 640–75 (1929).

(2) To discuss the published data and conclusions of other investigators on the basis of the results obtained in the present investigation.

II. Procedure

Twenty 1- by 1- by 6-inch test pieces of each commercial body were fired in laboratory kilns to cone 04, twenty to cone 2, and twenty to cone 6, approximately equivalent to temperatures of 1925°F, 2075°F, and 2175°F, respectively.

The average transverse strength or modulus of rupture for each body was determined by breaking ten of the specimens in each sample by application of a concentrated load at the center of a 5-inch span. The remaining ten specimens in each sample were subjected to thermal shock before transverse strength determinations were made. The per cent reduction in strength, based on initial strength, was then calculated.

The thermal shock test was planned to be equivalent to the more severe conditions to which the material might be subjected in service, and in addition, the test temperature selected was above the inversion temperature of quartz.

Thermal shock was produced by heating the samples for fifteen minutes entirely within a gas-fired muffle furnace maintained at 1100°F, following which they were removed and cooled for fifteen minutes by an air blast applied to one face. The cycle was repeated eight times.

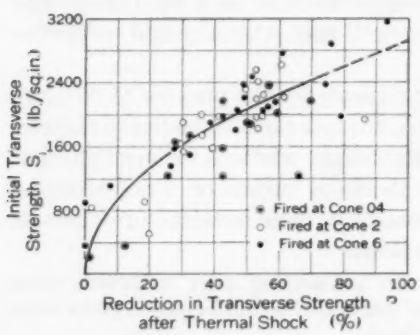

FIG. 1.—Experimental data showing relation between initial strength and per cent reduction in strength. Average curve plotted from the equation:

$$S_i = M_{100} \times \left(\frac{P}{100}\right)^{1/n}$$

where M_{100} is 2900 lb. per sq. in. and n is 2.

The method was essentially that of Parmelee and Westman but differed in the size of the test pieces, the temperature of the furnace, and the length and number of heating and cooling periods.

III. Experimental Data

All modulus of rupture values, or initial strengths, for the bodies were plotted against corresponding per cent reduction values and a smooth curve was drawn showing the general trend of the field (Fig. 1). Each point represents the average results from ten specimens before thermal shock and ten specimens after thermal shock. There are three such points for each material tested. The values of modulus of rupture after thermal shock, or final strengths, were also plotted against per cent reduction in strength in Fig. 2. The curve in the

figure was made to correspond to that of Fig. 1 by calculating the final strength values from values on the curve in Fig. 1. The general relationship between final and initial strength corresponding to the curve values of Figs. 1 and 2 is shown in the curve of Fig. 3. The points representing the experimental data are also plotted for comparison.

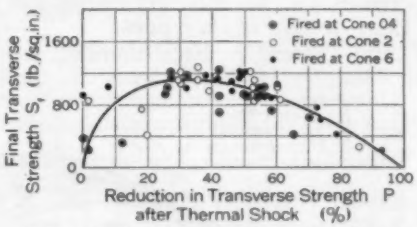

FIG. 2.—Experimental data showing relation between final strength and per cent reduction in strength. Average curve plotted from the equation:

$$S_f = M_{100} \times \left(\frac{P}{100}\right)^{1/n}\left(1 - \frac{P}{100}\right)$$

where M_{100} is 2900 lb. per sq. in. and n is 2.

These are "average curves" and are intended to indicate only the general trend of the data. The use of broken-line curves indicates the uncertainty of the trend in the region of the higher values of per cent reduction in Figs. 1 and 2, and of initial strength in Fig. 3.

Individual curves, each based on three points and representing one body, are shown in composite form in Fig. 4. The general form of each curve is fixed to some extent by the three plotted points, in that they indicate the presence of a maximum value for final strength. The curves in general have the same form as the average curves.

To secure a more positive indication of the trend of the relation between initial and final strength, additional tests were made on an individual body, covering a firing range from cone 09 to cone 9, corresponding approximately to temperatures of from 1700 to 2300°F. Initial strength ranged from approximately 800 to 3200 lb. per sq. in.

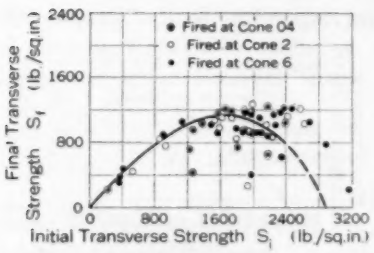

FIG. 3.—Experimental data showing direct relation between initial and final strength. Average curve plotted from the equation:

$$S_f = S_i\left[1 - \left(\frac{S_i}{M_{100}}\right)^n\right]$$

where M_{100} is 2900 lb. per sq. in. and n is 2.

The data are plotted in Fig. 5, in which each point represents the average results from ten test pieces before thermal shock and ten test pieces after thermal shock.

The results show definitely the presence of a maximum value for final strength and indicate that the general form of the individual and average curves is correct. In addition it seems probable from Fig. 5 that with increased vitrification and high initial strength development, final strength will decrease and finally approach zero.

IV. Results

The data indicate, for the firing range studied, that

(1) Per cent reduction in strength increases as initial strength increases, *i.e.*, the stronger bodies lose a greater percentage of their strength than do the weaker ones.

(2) Strength after thermal shock, or final strength, increases to a maximum and then declines, as the strength before thermal shock, or initial strength, increases.

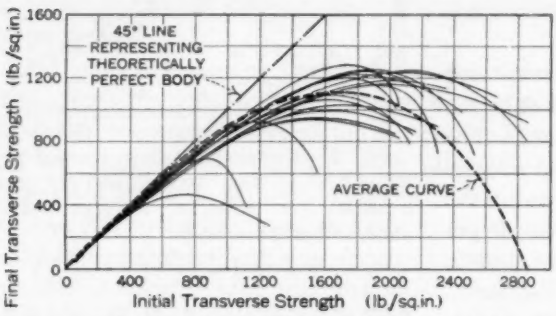

FIG. 4.—Relation between initial and final strengths for all bodies tested.

If it is accepted that the average exponential curves of Figs. 1, 2, and 3 correctly represent the test results, the properties of these mathematical curves define the following relations between initial strength, final strength, and per cent reduction in strength.

(1) Initial Strength and Per Cent Reduction

All values of per cent reduction will lie between 0 and 100 and can be expressed as some fractional part of 100, while the relation between initial strength and the strength corresponding to 100% reduction can also be expressed as a ratio. It is evident that this ratio and the per cent reduction are dependent variables which will change as the initial strength changes.

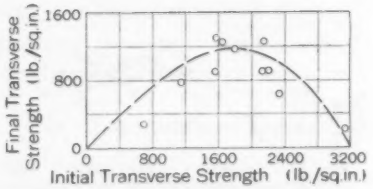

FIG. 5.—Relation between initial and final strength for an individual body.

While any particular equation selected may not completely satisfy all conditions it will offer a means of systematic variation of the relation between strength before and after thermal shock and per cent reduction, from which a helpful analysis of the problem can be made. Such a relationship, which fits the test data fairly well, can be expressed by the equation:

$$P = 100 \left(\frac{S_i}{M_{100}}\right)^n \qquad (1)$$

Where P = reduction in strength (%)
S_i = initial strength, modulus of rupture in lb./sq. in., corresponding to per cent reduction, P
M_{100} = initial strength, modulus of rupture in lb./sq. in., corresponding to 100% reduction
n = variable exponent

In more convenient form equation (1) becomes

$$S_i = M_{100}\left(\frac{P}{100}\right)^{1/n} \tag{2}$$

(2) Final Strength and Per Cent Reduction The relation between final strength and per cent reduction in strength can be readily obtained from equation (2) since the final strength is always equal to the initial strength multiplied by the factor $\left(1-\frac{P}{100}\right)$, where P is the per cent reduction.

Let S_f = strength after thermal shock, or final strength, modulus of rupture in lb. per sq. in. corresponding to per cent reduction, P:

$$\text{Then} \qquad S_f = S_i\left(1 - \frac{P}{100}\right) \tag{3}$$

$$\text{but} \qquad S_i = M_{100}\left(\frac{P}{100}\right)^{1/n} \tag{2}$$

$$\text{so that} \quad S_f = M_{100}\left(\frac{P}{100}\right)^{1/n}\left(1 - \frac{P}{100}\right) \tag{4}$$

From (4), S_f will be zero when P is 0 and 100.

Placing the first derivative of S_f with respect to P equal to zero, S_f becomes a maximum when

$$(n + 1)P = 100 \tag{5}$$

For any positive value of n, S_f will have a maximum value, *i.e.*, strength after thermal shock will increase to a maximum and then decline.

V. Discussion of Mathematical Relationships

(1) When M_{100} Is Variable and n Is Constant The solid-line curves in Fig. 6 are plotted from equation (2), where n is 2 and M_{100} is 1200, 1600, 2000, and 2400 lb. per sq. in., respectively. They represent the relation between initial strength and per cent reduction.

The broken-line curves represent the corresponding relation between strength after thermal shock and per cent reduction and are plotted from equation (4).

When n is kept constant and M_{100} varied, the per cent reduction corresponding to maximum strength after thermal shock remains fixed, for S_f is a maximum when $(n + 1)P = 100$. A group of curves for a different value of n will have a fixed but different value for the per cent reduction corresponding to maximum strength after thermal shock.

(2) When n Is Variable and M_{100} Is Constant

In Fig. 7 the light solid lines are plotted from the same general equation (2), but in this case M_{100} is kept constant at 2000 lb. per sq. in. and n is allowed to vary. When $n = 1$, the equation represents a straight line.

For values of n greater than one, a series of curves can be plotted which will rise more or less sharply from the origin, will be concave downward, and will approach M_{100} with gradually decreasing slope.

The broken-line curves again represent the corresponding relations

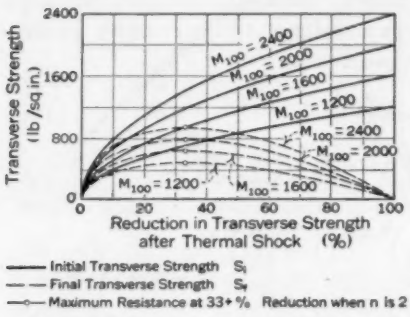

FIG. 6.—Graphic relationship between initial and final strengths and per cent reduction based on mathematical derivation. Plotted from the equations:

$$S_i = M_{100}\left[\frac{P}{100}\right]^{1/n}$$

$$S_f = M_{100}\left[\frac{P}{100}\right]^{1/n}\left[1 - \frac{P}{100}\right]$$

where M_{100} is constant and n is variable.

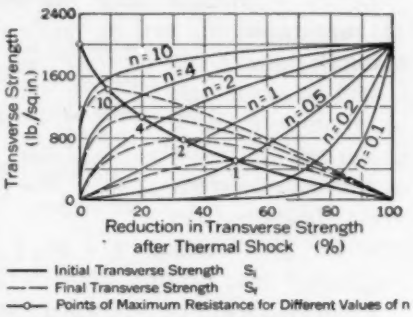

FIG. 7.—Graphic relationship between initial and final strengths and per cent reduction based on mathematical derivation. Plotted from the equations:

$$S_i = M_{100}\left[\frac{P}{100}\right]^{1/n}$$

$$S_f = M_{100}\left[\frac{P}{100}\right]^{1/n}\left[1 - \frac{P}{100}\right]$$

where M_{100} is variable and n is 2.

between strength after thermal shock and per cent reduction. They are plotted from equation (4).

As the relationship between transverse strength and per cent reduction changes from that represented by a straight line when n equals 1, to relationships represented by curves which are concave downward when n is greater than 1, the point of maximum strength after thermal shock changes from 50% reduction to lesser values as n increases, *i.e.*, the more abruptly the curve representing the relation between transverse strength before thermal shock and per cent reduction rises from the origin, the lower will be the per cent reduction at which the body will attain its maximum strength after thermal shock.

The heavy solid-line curve represents the maximum strength after thermal shock corresponding to different values of n.

(3) Initial and Final Strength The direct relation between initial and final strength is obtained by combining equations (1) and (4) and eliminating P.

Thus
$$S_f = S_i \left[1 - \left(\frac{S_i}{M_{100}}\right)^n\right] \tag{6}$$

from which it follows that S_f will be zero when S_i is equal to zero and M_{100}.

Placing the first derivative of S_f with respect to S_i equal to zero, S_f becomes a maximum when

$$S_i = \frac{M_{100}}{(n+1)^{1/n}} \tag{7}$$

The direct relation between initial and final strength is shown graphically in Fig. 8, having been plotted from equation (6). The curves indicate that, for a fixed value of M_{100}, resistance to thermal shock increases with increase in value of the exponent n, and that the higher the value of n, the more abruptly the resistance falls off after the maximum point is reached.

The relation between initial and final strength for a fixed value of n with M_{100} variable is not shown. It is evident, however, that the increase in maximum final strength is directly proportional to the increase in the value of M_{100}.

(4) $S_{f\,(max)}$ in Terms of M_{100} and n, with Corresponding Values of S_i and P The direct relation between maximum final strength, initial strength corresponding to 100% reduction (M_{100}) and n, is obtained by substitution in equation (4) of the value of P corresponding to maximum final strength, given in equation (5); or by substitution in equation (6) of the value of S_i corresponding to maximum final strength, given in equation (7).

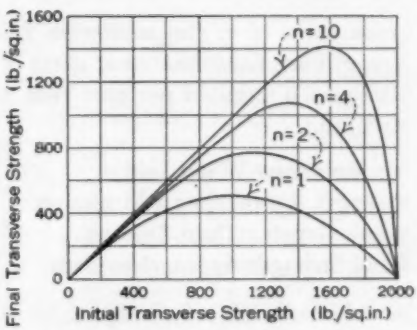

FIG. 8.—Theoretical relationship between initial and final strengths based on mathematical derivation. Plotted from the equation:

$$S_f = S_i \left[1 - \left[\frac{S_i}{M_{100}}\right]^n\right]$$

where M_{100} is constant and n is variable.

In either case

$$S_{f(max)} = \left[\frac{n}{(n+1)^{\frac{n+1}{n}}}\right] M_{100} \tag{8}$$

From equations (7) and (8) it is seen that, in the limit as n becomes infinite

both $S_{f(\max)}$ and the corresponding value of S_i approach M_{100}; and as n approaches zero, $S_{f(\max)}$ approaches zero, and S_i approaches $\frac{M_{100}}{e}$, where e is the base of Napierian logarithms.

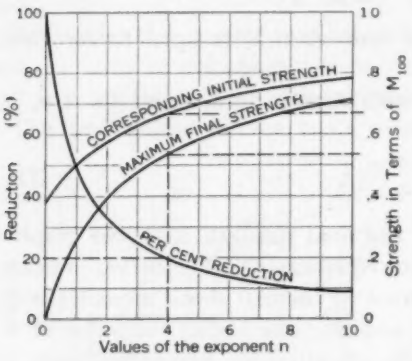

FIG. 9.—Relation between maximum values of S_f and corresponding values of S_i, P, and n.

Values of P corresponding to maximum values of S_f are given by equation (5)

$$(n + 1)P = 100$$

As n approaches zero, P approaches 100, and as n becomes infinite, P approaches zero.

These general relationships are shown graphically in Fig. 9 for values of n from 0 to 10.

It has been shown that for a given characteristic relationship between initial and final strengths, there is a corresponding value of n. The curves indicate that for any given value of n, the maximum final strength and corresponding initial strength are fixed fractional parts of M_{100}. For any value of n there is also a fixed value of per cent reduction corresponding to maximum final strength.

(5) Relations When Initial Strength Approaches a Minimum Value Greater Than Zero as Final Strength Approaches Zero

In the case in which the initial strength approaches a minimum value greater than zero, as final strength approaches zero, the curve representing the relationship may be considered to have been translated parallel to the X-axis a distance equal to the intercept C on the X-axis. The range of values for final strength remains unchanged, while each value of initial strength is increased by amount C. Thus the relation between initial and final strength becomes

$$S_f = (S_i - C)\left[1 - \left(\frac{S_i - C}{M_{100} - C}\right)^n\right] \qquad (9)$$

As initial strength increases from C to M_{100}, and the final strength increases from 0 to a maximum and then decreases to 0, the per cent reduction decreases from 100 to a minimum value and increases again to 100.

The relationships, when n is 2, are shown graphically in Fig. 10.

(6) Application to Experimental Data

The characteristics of individual bodies are shown by curves in Fig 4. In form, these curves closely resemble the "average curve" of Fig. 3 which is repeated for comparison. In each case the final strength increases to a

maximum and then decreases with increasing initial strength. While the data available are not sufficient for exact determinations of the constants for the several bodies, the values of M_{100} range from 1200 to 4000 lb. per sq. in. and n is, in all cases, greater than 1.

Values for initial and final strength for all bodies below maximum resistance to thermal shock lie in a comparatively narrow field slightly below the 45° line. It is evident, however, that each body has its individual characteristics for, as the maximum points are approached and passed, the curves become widely divergent. In preliminary experiments, only small differences were obtained in final strength corresponding to quite large differences in initial strength. The reason is now apparent for, at the flat upper part of the average curve (Fig. 4) representing maximum resistance, final strength apparently remains unchanged at 1080 lb. per sq. in., while initial strength changes from 1400 to 1940 lb. per sq. in.

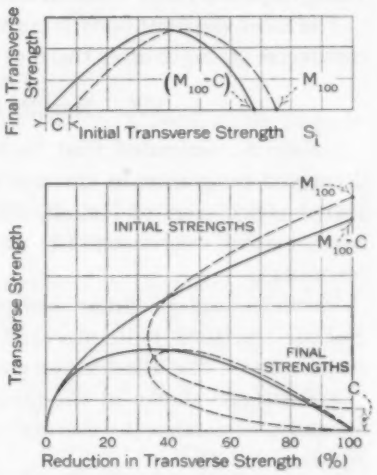

FIG. 10.—Relation between initial and final strength and per cent reduction when decreasing initial strength approaches a constant C, as final strength approaches zero.

This also may offer some explanation of the discrepancies between service tests and laboratory thermal shock tests. Laboratory tests usually are made on refractories which in their manufacture have attained an initial strength considerably below that which would correspond to 100% reduction in strength in a properly designed test. Most refractories tested would lie in the best range, below or approaching maximum resistance. In severe service, however, at least the exposed surface approaches complete vitrification, at which point the refractory is far beyond its maximum resistance.

Refractories which compare favorably at or below their maximum resistance might be widely different under service conditions as indicated by the divergence of the curves representing the relation between initial and final strength after they have passed their maximum value.

VI. Comparison with A.S.T.M. Spalling Test

The American Society for Testing Materials has tentatively defined "spalling,"[6] with reference to refractories, as "breaking or cracking of refractories to such an extent that fragments are separated, presenting

[6] Tentative Standards, A.S.T.M., 1927.

newly exposed surfaces of the residual mass." Comparisons of resistance to spalling are usually made by heating the specimens to a specified temperature, followed by quenching in air or water. The relative number of cycles required to spall 20% off each of the materials being compared indicates their relative resistance to spalling.

Such a test does not consider the effect of repeated thermal shock under test conditions which are not sufficiently severe to cause complete failure.

In the present investigation, comparison of the resistance of clay bodies to thermal shock has been made on the basis of the reduction in transverse strength produced by thermal shock.

The most resistant body is considered to be the one which has the highest transverse strength after thermal shock.

VII. Results of Other Investigators

Goodrich contended that high firing and development of vitrification decreased resistance to thermal shock, which agrees in general with the stated conclusions of Heindl, Mong, and Pendergast but contradicts the mathematical expression of their results, which, of course, they themselves contradict.

Parmelee and Westman contended that resistance to thermal shock in general increases with increased initial strength which contradicts the statements of the other investigators.

It has been shown in the present investigation that as initial strength increases, resistance to thermal shock increases to a maximum and then declines.

It is possible then that the disagreement in results may be explained by the nature of the materials studied in each investigation, for it is evident that for a limited field, resistance to thermal shock might either increase or decrease as initial strength increased.

Parmelee and Westman studied carbureter brick of comparatively low strength, while Heindl, Mong, and Pendergast studied sagger bodies and fire brick which either developed higher strength normally or were preheated at high temperatures before testing. It seems probable that the carbureter brick in the first instance all were below or near maximum resistance while the sagger bodies and fire brick in the other instances were beyond maximum resistance.

VIII. Improvement of Test

The progressive effect of repeated thermal shock must be determined before a comparison of bodies of different types can be made safely on the basis of a limited number of thermal shocks. It is possible that a body of low initial and final strength with low per cent reduction in a standard test might have a higher final strength than a body having high initial

and final strength with a high per cent reduction in a standard test, if compared after a large number of thermal shocks.

Since vitrification is known to decrease resistance to thermal shock it is important to know how a body would behave when vitrified to a degree corresponding to that which would be produced by service conditions.

The greatest difference between bodies, as determined in a thermal shock test which does not affect their vitrification, appears after they have passed their maximum resistance and are approaching vitrification. For this reason it is probable that comparisons of bodies could best be made by determining their resistance throughout the range of firing from a very soft to a vitrified structure.

IX. Summary

Conclusions of other investigators are contradictory because they apply only to limited fields in each case.

The results of the present investigation indicate that in general, initial strength and per cent reduction in strength increase as strength after thermal shock increases to a maximum and then declines.

Acknowledgment The data presented in this paper were obtained in an investigation which was conducted by the Engineering Experiment Station of the University of Illinois, of which M. S. Ketchum, Dean of the College of Engineering is Director, in coöperation with the Clay Products Association. The research was carried out in the Department of Ceramic Engineering of which C. W. Parmelee, Professor of Ceramic Engineering, is the head, and of which R. K. Hursh, Professor of Ceramic Engineering, was the acting head during the completion of the work.

Acknowledgment is made to C. W. Parmelee for his coöperation and assistance during the early part of the investigation; to R. K. Hursh for his interest and advice and especially for his critical survey of the material during its preparation for publication; and to G. H. Duncombe, Jr., ceramic engineer for the Clay Products Association, for his many helpful suggestions throughout the progress of the work.

Bulletin, No. 229, published by the Engineering Experiment Station of the University of Illinois contains a detailed report of the investigation.

Department of Ceramic Engineering
University of Illinois
Urbana, Illinois

The
Journal of the American Ceramic Society

Ceramic Abstracts

The
Bulletin of the American Ceramic Society

for

1931

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The American Ceramic Society
2525 North High Street
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2525 N. High Street **Columbus, Ohio**

Journal *of the* American Ceramic Society

VOLUME 14, 1931

A Monthly Journal Devoted to the Arts and Sciences Related to the Silicate Industries

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Publication Offices: 20th and Northampton Sts., Easton, Pa.

Editor: Ross C. Purdy; *Assistant Editor:* Emily C. Van Schoick.

Committee on Publications: J. T. Littleton, *Chairman*, L. Navias, L. J. Trostel, A. E. R. Westman, Ross C. Purdy.

CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

Ross C. Purdy, Editor

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Vol. 10 **December, 1931** **No. 12**

Abrasives

Properties of aluminous abrasives. Henry R. Power. *Metal Ind.* [N. Y.], **29**, 249–50 (1931).—Cubical structure, angularity, the apparent density test, surface tenacity, the briquet test, the penetrometer test, open coating, and capillarity are discussed. See also *Ceram. Abs.*, **10** [7], 469 (1931). (*C.A.*)

Saw for fired clay units. Wappat, Inc., Division of Simmonds Saw & Steel Co. *Brick Clay Rec.*, **79** [6], 268 (1931).—A high-speed saw for cutting fired clay products operates at 3000 r.p.m., takes a 7-in. abrasive wheel, has a maximum cutting capacity of 2 in., and is fitted with an adjustable base for any depth from 0 to 2 in. Illustrated. E.J.V.

Grinding lithograph plates. Anon. *Abrasive Ind.*, **12** [10], 19 (1931).—The abrasive used is fine-grit silicon carbide although emery and silica sand are used in some instances. Abrasive action is brought about by steel balls $^3/_8$ to $^1/_2$ inch in diameter. With the plate in position, the abrasive grain and the balls are placed on it and enough water is added to "float" the abrasive. The bed is set in motion and as it oscillates, the inertia of the comparatively heavy balls brings about an abrasive action which imparts the correct mat surface for lithographic printing. The size of abrasive used determines the texture of the surface. Either coarse- or fine-grained surfaces can be produced, depending on the size of grain employed. The abrasive is replaced every 20 or 30 min. If the abrasive were used continually it eventually would be ground into a fine sludge by its own action and thus produce a mat surface too fine for practical purposes. E.P.R.

Abrasive band and disk grinder. Walls Sales Corp. *Metal Cleaning & Finishing*, **3** [9], 765–66 (1931).—Products finished on "Duplex-M" have a perfect straight grain finish with sharp edges. Illustrated. E.J.V.

Precision support in grinding. Anon. *Abrasive Ind.*, **12** [10], 17–18 (1931). E.P.R.

Special-purpose grinding machine. Churchill Machine Tool Co. *Mech. World*, **90** [2326], 99–100 (1931).—New designs suggest new spheres for their application and indicate the line along which development is progressing. Illustrated. E.P.R.

Special abrasive machines in crankshaft production. Anon. *Abrasive Ind.*, **12** [10], 13–16 (1931).—This article illustrates and describes some of the grinding operations followed. E.P.R.

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

Landis roll-grinding machine. ANON. *Engineering*, **132** [3420], 134–36 (1931); for abstract see *Ceram. Abs.*, **10** [1], 6; [4], 244 (1931). A.A.

Care in polishing for high-grade finish. CADILLAC MOTOR CAR CO. *Abrasive Ind.*, **12** [10], 33–36 (1931).—Polishing and buffing operations are described and illustrated. See also *Ceram. Abs.*, **10** [10], 671 (1931). E.P.R.

Paraffin oil as lubricant. CINCINNATI GRINDERS, INC. *Abrasive Ind.*, **12** [10], 26 (1931).—Data pertaining to the use of paraffin oil as a grinding lubricant are given. The heavier oils that were originally tried out were too expensive and left too great a residue on the finished work. The lighter nonviscous oil such as kerosene was too penetrating and had a comparatively low flash point which made the fire hazard rather high. A light paraffin oil served the purpose well, kept the wheel open, and overcame all of the above-mentioned objections. E.P.R.

PATENTS

Workhead for grinding machines. GEORGE E. GARNO AND EUGENE A. ENGSTROM. U. S. 1,823,893, Sept. 22, 1931. The combination with a rotatable chuck, means to open and close the chuck and means to start and stop the chuck, of a work-centering plug in the chuck, means actuated by the opening and closing means when the chuck is opened for moving the plug to work-centering position, and means actuated by the starting and stopping means when the chuck is started in rotation for moving the plug out of work-centering position.

Rubbing and grinding machine. HAROLD G. BARRETT. U. S. 1,825,299, Sept. 29, 1931. A machine of the character described embodying opposed coöperating rubbing elements between which the work is disposed, means for imparting a rotary and also a bodily reciprocatory movement to the work and the elements one with relation to the other, resilient means individual to the elements for maintaining the elements and the work in engagement, and means common to the resilient means for varying at will the stress thereof.

Polishing and grinding machine. CHARLIE L. HAWES. U. S. 1,825,455, Sept. 29, 1931. In a machine of the character described, an electric motor and a grinding wheel, a floating frame therefor, means for compensating the weight of the frame and contents, means for adjusting the grinding wheel relative to the frame, and traveling work-carrying means coöperating with the grinding wheel.

Truing mechanism. LESTER F. NENNINGER. U. S. 1,825,753, Oct. 6, 1931. A mechanism including a base or support, a carriage transversely shiftable thereon, a slide mounted on the carriage for in and out movement relative to carriage and base, means for imparting in and out movement to the slide during transverse movement of the carriage, the means including a template carried by the base, a follower carried by the slide for engagement with the template and a spring-pressed plunger carried by the slide and engaging the template in opposition to the contact for retaining the parts in operative relation, a tool-holding sleeve adjustably mounted on the slide, a truing tool carried thereby for adjustment therewith and relative thereto, and a shield member carried by the support and encircling the sleeve, the shield being transversely shiftable with the sleeve on movement of the carriage.

Grinding machine. CECIL W. HOPKINS. U. S. 1,825,797, Oct. 6, 1931. The combination of a pair of opposed grinding and regulating wheels forming a grinding throat therebetween, a work-rest blade within the throat, a positioning and ejecting member within the throat for limiting the insertion of the work piece therein and for axially ejecting it therefrom, and hydraulic means for actuating the member, including an intermittently operable pump.

Grinding head or attachment. FRANK R. MOORE. U. S. 1,825,883, Oct. 6, 1931.

An integral, substantially triangular housing, front and rear bottom idle rolls carried thereby, a front upper drive roll carried by the housing, driving connections for the drive roll, rear upper tension rolls pivotally carried by the housing, an endless abrasive belt passing over the drive roll and the idler rolls and beneath the tension roll, means for retaining the tension rolls in operative position with respect to the belt, means for effecting lateral adjustment of the tension rolls to maintain the effective surface portion of the belt in a true horizontal plane, an operating handle carried by the housing in advance of the tension rolls, and a yieldable pad carried by the bottom of the housing between the idler rolls and adapted to coact with the belt.

Grinding machine. WALDO J. GUILD. U. S. 1,826,070, Oct. 6, 1931. The combination with a grinding wheel, a workhead, and a reciprocatory table or carriage carrying one of the parts, of mechanical devices associated with the carriage to control its reciprocations in the grinding or working range of the wheel, and fluid pressure means to move the carriage to and from the range.

Grinding machine. HERBERT E. KEMPTON AND KEITH F. GALLIMORE. U. S. 1,826,178, Oct. 6, 1931. A grinding machine having, in combination, a carriage having a grinding wheel, a headstock adapted to support the work, a gage arranged to coact with the work, means for effecting a relative intermittent approaching movement, a relative reciprocation and a separation at the completion of the reciprocation between the grinding wheel and the work, the separating movement being instituted by the gage, means set in operation by the gage for slowing down the speed of the reciprocation during the last part of the grinding operation, and means set in operation by the gage for effecting a separation between the grinding wheel and the work surface before the first-mentioned separation between the grinding wheel and the work is completed.

Grinding wheel trimming fixture. JOHN W. PARKER. U. S. 1,826,219, Oct. 6, 1931. In combination a main frame, an auxiliary frame swiveled thereon, a grinding wheel trimming tool carried by the auxiliary frame, a pair of stop members rotatably mounted on the auxiliary frame, a single means for locking the stop members in any one of a plurality of rotatably adjustable positions against rotation relative to the auxiliary frame, and a stop member on the main frame in coöperative relationship with respect to the stop members.

Abrasive wheel. REVERE CHAPELL. U. S. 1,826,300, Oct. 6, 1931. A high-speed abrasive wheel composed of particles of abrasive material unitarily and rigidly united together by a bonding material, the proportion of bonding material to the abrasive being progressively greater radially outwardly from the inner diameter of the wheel to the periphery thereof.

Safety device for grinding machines. HAROLD E. BALSIGER. U. S. 1,826,445, Oct. 6, 1931. In combination, a grinding machine, a work carriage on the machine, an abrasive wheel, a work rest adapted to support the work against the pressure of the abrasive wheel, means for reciprocating the work carriage, means for moving the work rest to and from operative position, and means controlled by the movement of the work rest to render the carriage reciprocating means operative or inoperative.

Valve grinding machine. HARRY J. CRINER. U. S. 1,826,653, Oct. 6, 1931. Comprising a base, a motor saddle pivotally attached to the base, a motor secured upon the saddle, a handle united to the motor housing, a grinding wheel mounted upon one end of the motor shaft, a bearing united to the base, a valve shaft mounted in the bearing at an acute angle to the motor shaft, means secured upon the valve shaft adapted to receive and hold the stem of a valve to be ground, a flexible shaft coupled directly to the motor shaft and valve shaft, and means for adjusting the motor longitudinally.

Grinding wheel. GEORGE E. VANCE. U. S. 1,826,907, Oct. 13, 1931. In a grinding wheel, an annular tapered abrasive element and a pair of clamping collars one on each

side of the element to clamp the element therebetween, each of the collars being formed of two sheet-metal disks and a series of separate radially-extending ribs therebetween, together with means for connecting the disks and ribs together.

Grinding wheel guard. GEORGE E. SMITH. U. S. 1,827,270, Oct. 13, 1931. In combination with a grinding wheel of a grinder, a cover for the grinding wheel comprising a main casing mounted on the frame of the grinder concentric to the grinding wheel for rotative adjustment relative thereto, and a one-piece cap hinged on the main casing for enclosing the upper portion of the wheel and having its front edge adjustable toward and from the peripheral surface of the grinding wheel, the adjustment movement of the cap adapted to be imparted entirely independent of the hinged movement thereof.

Grinding or abrading machines. NORTON CO. Brit. 355,650, Sept. 9, 1931.

Grinding or abrading apparatus. WOLTERS MECHANISCHE KRATZEUFABRIK UND P. MASCHINENFABRIK. Brit. 356,035, Sept. 9, 1931.

Abrasive articles such as sandpaper, etc. A. E. WHITE. Brit. 356,183, Sept. 16, 1931.

Abrasive implements. H. WADE. Brit. 356,188, Sept. 16, 1931.

Centerless grinding machines. CINCINNATI GRINDERS, INC. Brit. 356,242, Sept. 16, 1931.

Tooth-wheel grinding machines. REISHAUER-WERKZEUGE AKT.-GES., E. KREIS AND A. RICKENMANN. Brit. 356,688, Sept. 23, 1931.

Centerless grinding machines. A. E. WHITE. Brit. 357,188, Sept. 30, 1931.

Art and Archaeology

Turquoise glazes with cuprous oxide. ARNULF HOLL. *Keramos*, **10** [18], 473–74 (1931).—The firing is the most critical period for red cuprous oxide glazes. It is possible to obtain a uniform red coloring in such glazes in small firing kilns, although in large kilns this is difficult. Chinese and Persian ceramists knew how to deal with this glaze as some of their ornaments show a blood red color on a deep blue turquoise ground. The most important factors for successfully obtaining such glazes are as follows: (1) The copper oxide for the turquoise blue ground must be protected from reduction influences during firing. (2) The glaze must be rich in alkali, sharply prefused and finely ground. (3) The dark red color composed mainly of chemically pure copper oxide or cuprous oxide must have a thin surface to protect it from reduction effects. In order to obtain a uniform turquoise ground not influenced by firing, the copper oxide is applied by itself and not to the frit or fritted glaze. The object is covered with a solution of copper oxide before glazing with a colorless glaze. For porous bodies, the solution consists of copper oxide and water; for dense or sintered bodies, the solution contains some adhesive substance. Its proportion depends on the porosity and color tone. The object is covered with the glaze after the copper oxide solution dries. The turquoise color develops during firing by the penetration of the copper oxide into the glaze which must be easily fusible. In order to obtain a color developing into red, copper oxide or cuprous oxide must be ground to a special fineness and applied thinly. This thin coat is important for a fine red as otherwise a greater amount of smoke is necessary to convert cuprous oxide into metallic copper. The composition and mixing proportions can be fixed only by tests because the kiln size, firing temperature, firing time, and influence of smoke are decisive factors. A kiln with a muffle is necessary for firing, and the reduction is artificially promoted by naphthalene or oil. The following batch was used with success:

	Parts by weight		Parts by weight
Crystallized soda	143.0	Chalk	10.0
Feldspar	55.9	Quartz	102.0
Zinc oxide	24.3	Tin oxide	15.1

The batch is fritted with zinc oxide, half of the weight, and the rest is added to the mill. The firing temperature varies between Seger cone 06a and 05a, depending on the firing time. With an increase of tin oxide content, the turquoise color changes into blue-green and with a constant coating of the body with copper oxide, the color becomes lighter. An ox-blood red is obtained by increasing the tin oxide content. See also *Ceram. Abs.*, **10** [5], 319 (1931). M.V.K.

Turquoise glazes. E. BERDEL. *Ceram. Ind.*, **17** [3], 195–98 (1931); for abstract see *Ceram. Abs.*, **10** [11], 749 (1931). W.W.M.

Requirements of pigments for the ceramic industry. ANON. *Farbe Lack*, 280, 295, 319 (1931).—A brief review of the properties desired in pigments for coloring ceramic ware and short descriptions of several pigments are given. (*C.A.*)

Beauty of Solon ware: a decorative art. EDWARD WENHAM. *Arts & Dec.*, **35** [5], 34–35 (1931).—Solon's pâte-sur-pâte (paste on paste) is not the opaque molded appliqués of Turner, Adams, etc., but is transparent over a dark background, thus producing remarkable effects of perspective and shading. The ware must be semiporcelain colored with oxides and fired hard enough for handling. After drawing the outline, the slip is painted on in successive coats allowing each to dry thoroughly before applying another and keeping the thickness gaged somewhat according to required modeling. It is produced now only at the Minton factory and is exhibited at the Pennsylvania Museum. E.B.H.

Enameling glass. FRANZ SKAUPY. *Chem. Zentr.*, **102** [6], 891 (1931); for abstract see *Ceram. Abs.*, **10** [8], 539 (1931). J.G.T.

Study of lighting. WALTER W. KANTACK. *Arts & Dec.*, **35** [4], 48–49 (1931).—A discussion of up-to-date lighting fixtures is presented. Illustrated. E.B.H.

Rare modern porcelains by Lenci of Italy. ANON. *Arts & Dec.*, **35** [5], 29–32 (1931).—Garden pottery and a bench of brilliant tile are illustrated. E.B.H.

Decorative pottery for entrance, garden, and porch. CHARLES ALMA BYERS. *Arts & Dec.*, **35** [5], 36–37 (1931).—Illustrated. E.B.H.

Ornaments for modern gardens. JULIET SANFORD. *Arts & Dec.*, **35** [2], 22–23 (1931).—Illustrations and descriptions are given. E.B.H.

Modern decorative figures. ANON. *Design*, **33** [4], 80 (1931).—The new Diana by Vally Wieselthier, now on exhibition at the Brooklyn Museum, is illustrated. See also *Ceram. Abs.*, **9** [3], 152 (1930). E.B.H.

Pottery and china animals as ornaments. EDWARD WENHAM. *Arts & Dec.*, **35** [2], 26–27 (1931).—Modern potters are producing excellent figures of animals and people. E.B.H.

Gifts of glassware and chinaware. ANON. *Arts & Dec.*, **35** [2], 50–53 (1931).—Specimens of tableware, glassware, and vases are illustrated. E.B.H.

Eastern crafts from a designer's viewpoint. FLOY K. HANSON. *Design*, **33** [3], 50–52 (1931).—Illustrated. E.B.H.

Decorating kiln. ANON. *Ceram. Ind.*, **17** [4], 288–91 (1931).—A full muffle, gas-fired, continuous decorating kiln in the Steubenville (Ohio) Pottery Co. is described. W.W.M.

Worthwhile restoration. ANON. *Art & Arch.*, **32** [1–2], 43–44 (1931).—A restorer of antiquities, C. J. Young of the Boston Museum of Fine Arts, has accomplished some skilful reconditioning. An encrustation of silicate deposits, defying acids, etc., was removed from a fine red-figured krater by firing in a kiln at 450°, slightly below the melting point of the glaze. The salts were reduced and sediment brushed off leaving the design free in minute detail. The vase had been broken and mended so after firing the fragments were refitted and mortised together. E.B.H.

Hopi craftsman. ANON. *Amer. Mag. Art*, **23** [2], 163 (1931).—The Museum of

Northern Arizona at Flagstaff held an exhibition of work (including pottery) of Pueblo Indians. E.B.H.

Excavation of the Galaz ruin, Mimbres Valley, N. M. BRUCE BRYAN. *Art & Arch.*, **32** [1–2], 35–42 (1931).—Vast numbers of shards of all types and design were brought forth. Until the system of tree rings was worked out, pottery offered the only clue to the chronology of cultures. The more advanced decorated Mimbres ware, the highest pueblo ceramic art, is of two classes: (1) geometric with designs of mathematical accuracy and (2) naturalistic with animal or human design. Cremations were found in narrow-mouthed bowls with wide-mouthed bowls inverted over them. Illustrated. See also *Ceram. Abs.*, **10** [5], 323 (1931). E.B.H.

Decorative design on Mimbres pottery. EDITHA L. WATSON. *Design*, **33** [3], 54–56 (1931).—The pottery of the Mimbrenos furnishes inspiration to decorators working with circular forms. Color combinations suggested by the originals are dull black on dead white, dark red on deep cream, turquoise or dark blue with silver on dead white, and Indian red and copper on cream. A medium between dark and light was obtained by the use of close parallel lines, done freehand. Illustrated. E.B.H.

Excavations at Eleusis. K. KOUROUNIOTES. *Art & Arch.*, **32** [1–2], 3–15 (1931).—Eleusis was one of the most famous sanctuaries of Greece. The excavation of a village dated 2000 B.C. uncovered many interesting pieces of earthenware. Illustrated. E.B.H.

Camirus necropolis. G. JACOPI. *Illus. London News*, **179**, 121 (1931).—J. is Superintendent of Excavations in the Ægean islands belonging to Italy. The old Dorian settlement at Camirus in Rhodes has yielded burial vases 6 ft. high containing bodies of adults. H.H.S.

BOOKS

New Glass-Painting Art. (Neue Glasmalkunst.) CLEMENTS GAHLEN. Published by Reichsverband Deutscher Glasmalerein e.V. Alexander Duncker, Leipzig. 75 pp. Price 2.85 Rm. Reviewed in *Glass Ind.*, **12** [10], 203 (1931).—This is an important review of the glass-painting art of the present day. The introduction, consisting of less than a dozen pages and entitled "Historical and Fundamental," makes up the greater portion of the text. The body of the work consists of some thirty illustrations of modern examples of the glass-painting art, each of which is accompanied by a short paragraph of explanation. See also *Ceram. Abs.*, **10** [2], 93 (1931). E.J.V.

Attic Vase Paintings in the Museum of Fine Arts, Boston. I. L. D. CASKEY AND J. D. BEAZLEY. ix + 57 pp. 30 plates. The Museum, Boston, 1931. Price $16.80. Reviewed in *Times Lit. Supp.*, **30**, 563 (1931). H.H.S.

Catalogue of Greek Vases in the Royal Ontario Museum, Toronto. D. M. ROBINSON, C. G. HARCUM, AND J. H. ILIFFE. 2 vols. viii + 288 pp. 108 plates. Univ. of Toronto Press, 1931. Price $10.00. Reviewed in *Times Lit. Supp.*, **30**, 563 (1931). H.H.S.

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Corpus Vasorum Antiquorum: Spain. Vol. 1. The National Museum, Madrid. J. R. MELIDA. Milford, London, 1931. Price 24s. Reviewed in *Times Lit. Supp.*, **30**, 563 (1931). H.H.S.

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Old Civilizations of the New World. A. H. VERRILL. viii + 394 pp. Williams &

Norgate, London, 1931. Price 21s. Reviewed in *Geograph. Jour.*, **78**, 186 (1931).—The discoveries of archaeologists in North and South America are related. H.H.S.

Ancient Pottery in the Museum of Leiden. II. Greek Vases. J. P. J. Brants. Martinus Nijhoff, The Hague, 1931. Reviewed in *Times Lit. Supp.*, **30**, 563 (1931). H.H.S.

The Ayar-Incas (Peru). Miles Poindexter. 2 vols. 633 pp. Horace Liveright, New York, 1931. Price $10.00. Reviewed in *Times Lit. Supp.*, **30**, 584 (1931). H.H.S.

Foundation Figurines and Offerings. E. D. van Buren. xvi + 81 pp. 20 plates. Hans Schoetz, Berlin, 1931. Price 40 Rm. Reviewed in *Times Lit. Supp.*, **30**, 584 (1931).—The foundation deposits of Mesopotamia are studied. H.H.S.

PATENTS

Design for soap holder, etc. Stephen D. Baker. U. S. 85,150 and 85,151, Sept. 22, 1931.

Design for glass tumbler, etc. Robert J. Beatty. U. S. 85,152, Sept. 22, 1931.

Design for plate. James H. Wilson. U. S. 85,220, Sept. 22, 1931.

Design for bottle. Edwin W. Fuerst. U. S. 85,233, Sept. 29, 1931. Milton Sierad. U. S. 85,307, Oct. 6, 1931.

Design for drinking glass. John Kirkpatrick. U. S. 85,246, Sept. 29, 1931.

Design for jar. Shelby V. Knepper. U. S. 85,247, Sept. 29, 1931.

Design for covered dish, etc. Walter Lindley. U. S. 85,249, Sept. 29, 1931.

Design for teapot. Charles D. La Follette and Harold A. Jahraus. U. S. 85,292, Oct. 6, 1931.

Design for hollow glass brick. Samuel B. Bowman. U. S. 85,320, Oct. 13, 1931.

Design for article of bric-a-brac. Frederick Carder. U. S. 85,323, Oct. 13, 1931.

Design for stove, etc. Joseph C. Clark. U. S. 85,324, Oct. 13, 1931. Alfred J. Reedy. U. S. 85,344 and 85,345, Oct. 13, 1931. Jacob Teller and Arthur P. Schulz. U. S. 85,353 and 85,354, Oct. 13, 1931.

Design for combination heater and range. Charles Rogers and Clarence Rogers. U. S. 85,348, Oct. 13, 1931.

Decalcomania. Roger Tull. U. S. 1,826,228, Oct. 6, 1931. A decalcomania characterized in that it includes decalcomania paper, and a design thereon having a coat including nitrocellulose, gum, plasticizer, a solvent, and color pigments, and having a second coat including oil paint ground in varnish.

Producing designs on tile. Léon V. Solon. U. S. 1,826,262, Oct. 6, 1931. Forming a tile blank having an undulating surface, consisting of angularly elated plane surfaces, applying a glaze evenly over the surface of the tile, firing the tile, and maintaining the tile with its glazed surface in a generally horizontal position during firing so that the glaze in molten state flows toward the lower parts of the surface to produce a desired design.

Enamel. Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler. Ger. 528,955, May 22, 1929; see also *Ceram. Abs.*, **10** [8], 550 (1931). (*C.A.*)

Cement, Lime, and Plaster

Researches on the rotary kiln in cement manufacture. XXVI. Geoffrey Martin. *Rock Prod.*, **34** [19], 54–59 (1931).—M. calculates the exit temperatures of the gases from rotary kilns when the slurry moisture varies between 0 and 40% but the entering air is preheated to various degrees, allowing the same external radiation from the kiln shell as occurs in an ordinary rotary kiln. Methods for interpolating for any operating condition are illustrated. Based on the data presented, M. points out that definite

lower and upper limits to kiln efficiency exist. **XXVII.** *Ibid.*, **34** [20], 40–43 (1931).—Tables are calculated from extrapolated values of specific heats from which it is possible to calculate in a simple manner the weight of steam producible under almost any circumstances for any fuel consumption, slurry moisture, and degree of preheating of the entering air. These tables should be particularly useful to works engineers. **XXVIII.** *Ibid.*, **34** [21], 44–47 (1931).—A formula for calculating heat flow through a compound wall and factors affecting heat transfer are given. For Parts XXIV and XXV see *Ceram. Abs.*, **10** [11], 754 (1931). W.W.M.

Report of the Committee on Furnaces of the Association of German Cement Manufacturers for 1930–31. E. SCHOTT. *Tonind.-Ztg.*, **55** [69], 984–85; [70], 995–96 (1931).—During the last year, the Committee has carried on investigations on a Lepol furnace and a shaft furnace. The Lepol furnace is a new type of rotary kiln comprising a cooling drum which uses the waste heat by means of a traveling grate. Sketches of the furnace as well as heat balances are given. The furnace shows a high output; almost no dust is developed and the smoke from the chimney is generally grayish-white. The shaft kiln is of the Andreas type, being fed without preliminary briqueting. A plan of the furnace together with a heat balance is given. No CO was found. W.M.C.

Can cement durability be predicted? E. T. CARLSON AND P. H. BATES. *Eng. News-Rec.*, **107** [4], 130 (1931).—Results obtained in a study of Merriman's method of testing cements as "a measure of the extent to which the constituents of a cement have been combined in that it determines their resistance to the sugar-lime solution" are reported. A large number of cements of various brands were examined. The index of disintegration was determined by the sugar-lime solution method and 1:3 standard sand briquets were stored in 10% sodium sulphate solution to determine the rate of disintegration. Although the results indicate that in general, those cements having a low index are more resistant to the action of sodium sulphate than those with a high index, the variation is so great that it is impossible to predict the behavior of a given cement from its index. A correlation of tricalcium aluminate content and rate of disintegration was attempted, but here again the results varied so much as to be of little more value than to indicate a general trend. A number of inaccuracies of the method are discussed. No relation could be observed between free-lime content and the index of disintegration. From this it would seem to be doubtful that this index is indicative of the completeness with which a cement has been manufactured. There are no data available for these cements to correlate this index or the disintegration of briquets with actual durability of concrete in the field. W.L.

Determination of cement fineness. C. F. PINKERTON. *Rock Prod.*, **34** [21], 72 (1931).—A method for a sieving test for fineness of cement together with results obtained by two different operators is given. A saving of time over the standard method is made. W.W.M.

Lime content of alumina cements. H. KÜHL AND SETSUO IDETA. *Zement*, **20** [12], 261–64 (1931); *Rock Prod.*, **34** [19], 90 (1931); see also *Ceram. Abs.*, **10** [2], 96 (1931). W.W.M.

Thermal phenomena of the setting of alumina cements. I. RENATO SALMONI. *Giorn. chim. ind. applicata*, **13** [8], 383 (1931). M.V.K.

Composition of Portland cement. A. C. DAVIS. *Cement & Cement Mfg.*, **4** [6], 637 (1931).—Variations in the composition of Portland cement, the application of various formulas, *e.g.*, the hydraulic modulus and the silica modulus, and their relation to the physical properties of the cement are discussed. W.L.

Manufacture of plaster. J. DUCHEZ AND E. DUCHEZ. *Rev. mat. constr. trav. pub.*, No. 262, pp. 271–76 (1931).—Curves of firing of gypsum show that dehydration occurs twice and that it is easier to supervise the calcining of the powder than that of pieces.

Calcining is more regular in a retort than in a rotary kiln. No regularity is possible in a chambered kiln. It is easier to make corrections with calcining in a retort than with other systems of kilns. M.Y.H.

Plaster defects. A. M. TURNER. *Rock Prod.*, **34** [21], 48–51 (1931).—T. defines the various terms for plaster complaints with illustrations and gives the causes, remedies, and methods of preventing them. The information is of value chiefly to distributors and consumers of plaster. W.W.M.

Causes of the hardening of gypsum. L. FORSÉN AND C. R. W. MYLIUS. *Finska Kemistsamfundets Meddelanden*, **40**, 39–42 (1931).—This is a theoretical discussion based on coördination valences. The series of reactions proposed are $2CaSO_4 \cdot {}^1/_2H_2O$ (soluble) $\longrightarrow Ca_2(S_2O_9H_2) \longrightarrow 2Ca^{++} + (S_2O_9H_2)^{----} \longrightarrow + 3H_2O \longrightarrow 2Ca + 2(SO_6 \cdot H_4)^{--} \longrightarrow 2Ca(SO_6H_4) \longrightarrow 2(CaSO_4 \cdot 2H_2O)$ (insoluble). (*C.A.*)

Causes of discoloration of clinker and its effect on soundness and strength. KATSUZO KOYANAGI. *Rock Prod.*, **34** [10], 68–69 (1931).—Test data are tabulated. W.W.M.

Determination of soluble silica in pozzuolana and pozzuolanic cements. G. BAIRE. *Rev. mat. constr. trav. pub.*, No. 262, pp. 268–71 (1931); see also *Ceram. Abs.*, **10** [3], 171 (1931). M.Y.H.

BOOK AND BULLETINS

Some Writers on Lime and Cement. CHARLES SPACKMAN. Price $3.75. Reviewed in *Rock Prod.*, **34** [19], 92 (1931); see also *Ceram. Abs.*, **9** [11], 919 (1930). W.W.M.

Investigation of blended Portland cement. EDGAR S. MCCANDLISS AND HENRY H. ARMSBY. *Bull. Mo. School Mines & Met.*, **4** [4], 76 pp. (1918).—Quartz sand may be added to Portland cement before final grinding to the extent of about 40% by weight and the resulting blended cement will, after sufficient grinding, satisfactorily pass the requirements of the present standard specifications of the A.S.T.M. for Portland cement. The presence of quartz sand with the clinker in a tube mill facilitates fine grinding of the latter. The satisfaction of the present standard test for soundness of cement should not be depended on alone to qualify a cement for acceptance. Some tests for strength should also be made. E.C.C.

Basic conditions of the production of anhydrite cement. P. P. BUDNIKOFF AND W. LECHOJEV. *Research Inst. Silicate Ind.* [Charkov], **17**, 18 pp. (1930).—Data are given on the composition, properties, production, and use of anhydrite cement. See also *Ceram. Abs.*, **9** [7], 505 (1930). M.V.K.

Enamels

Spraying finish coat sheet-steel enamels. ANON. *Better Enameling*, **2** [5], 14–17 (1931).—The equipment necessary and the importance of the proper consistency of the enamel are discussed, and rules for spraying are given. W.C.O.W.

Printing processes for marking porcelain enamel products. ANON. *Better Enameling*, **2** [5], 26–28 (1931).—Printing on enamel may be done with a rubber stamp using an oxide "ink." Another method utilizes varnish on the rubber stamp, finely-ground oxide being then dusted on the imprint. For extremely fine lines or accurate calibration, a more complicated process is used, requiring an indirect or offset method of printing. A steel die is engraved by having the design cut into it. The ink is then transferred from this die to a rubber pad and thence to the enameled ware by means of a press. For extremely high-speed production some plants use a regular job printing press constructed to meet their requirements. For less particular work another offset process substitutes an embossed engraving for the steel die. W.C.O.W.

Imitation majolica enameling. ANON. *Machinery* [London], February, 1931; *Emaillewaren-Ind.*, **8** [33], 262 (1931).—Enamels used for the production of imitation majolica belong to the transparent group and are dusted on a white enamel while it is still hot. The enamel melts on the white ground and produces the desired effect. It has a melting point of 600° and contains a large quantity of lead oxide. The fusing point of the majolica enamel must be lower than the fusing point of the white ground enamel. To obtain a black porcelain enamel, the black enamel powder is dusted on the first layer or the white ground coat. When the black enamel is applied directly to the white enamel, a blue-gray color is obtained depending on the thickness of the enamel coat. In some cases the black enamel can be applied directly on the hot cast. M.V.K.

Soiled wet enamels. VIELHABER. *Emaillewaren-Ind.*, **8** [32], 250–51 (1931).—It is almost impossible to obtain a white wet enamel without small gray, black, or reddish-brown spots. These originate during the fusing of an enamel in the following cases: (1) The refractory lining of the kiln may dissolve in one place and grog particles get into the fusion. The particles are ground with the enamel and get into the enamel layer producing gray-yellow spots. (2) The outlet of the tank or of the kiln is closed with a clay cork, particles of which get into the enamel but do not dissolve. During grinding they are pulverized and produce gray spots in the white enamel layer. (3) If the mass is stirred up in the fusing kiln, the bar of the crutch oxidizes. A layer of cinders may fall into the enamel mass and dissolve into iron oxide which produces black spots in the enamel. (4) The mill itself can also soil the enamel. If the cement and porcelain linings are ground off, the millstones are affected by grinding and their particles get into the enamel. (5) The admixtures to the mill also contain impurities besides dust and dirt. The clay added may contain lime and lime combined with carbonic acid. Iron pyrites, pyrite, and marcasite, composed of iron and sulphur, are especially harmful. (6) It is possible that under certain circumstances tin oxide changes into stannous oxide having a brown-black color. V. emphasizes the necessity of controlling the state of the mill and the investigation of the clay for the presence of iron pyrites. M.V.K.

Cold enamels. WALTER OBST. *Emaillewaren-Ind.*, **8** [34], 265–66 (1931).—O. describes the composition and properties of different cements and cold enamels used for repairing enameled objects. M.V.K.

Granite enamel. ANON. *Emaillewaren-Ind.*, **8** [31], 37 (1931).—An ordinary enamel is ground with a large quantity of water but without additions of clay. During enameling the enamel dissociates from water and forms clouds and veins. Such clouds and veins vary in size with the fineness of the enamel and produce various designs. In order to increase the effect of clouds, greater quantities of opacifiers are used (up to 10%), and for obtaining finer designs, small quantities of clay (1 to 2%), quartz, or soluble glass are used. Apparatus for obtaining such a granite effect on the ware is described. M.V.K.

Enameling cast iron at lower temperature. ANON. *Machinery* [London], February, 1931; *Emaillewaren-Ind.*, **8** [29], 229 (1931).—The cast iron is cleaned by a sand jet, sprayed with a black enamel, dried, fired, cooled, sprinkled with white enamel, dried, and fired again. The enamels have a fusing point of about 700°, are free from lead, and produce a uniform black or white layer. M.V.K.

Effect of smelter atmospheres on dry-process enamels for cast iron. A. I. ANDREWS AND H. W. ALEXANDER. *Metal Cleaning & Finishing*, **3** [9], 762 (1931); see also *Ceram. Abs.*, **10** [7], 484 (1931). E.J.V.

Metal base for enameling. J. T. HAY. *Ceram. Ind.*, **17** [4], 292 (1931).—H. relates the steps in making the metal base for enameling, from the selection of raw materials to the rolling of the iron sheets. The reduction of oxides to metals by carbon is discussed. W.W.M.

Equipment for cleaning metal. IX. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [9], 711–14 (1931).—This instalment consists of a discussion of temperature with relation to the cleaning operations. A brief explanation of the various methods of measuring temperature effects is given with conversion tables for the Centigrade and Fahrenheit scales. Illustrated. For Part VIII see *Ceram. Abs.*, **10** [11], 757 (1931). E.J.V.

Buffer action of cleaning solutions. C. L. MANTELL. *Metal Cleaning & Finishing*, **3** [9], 723–26 (1931).—The phenomenon of buffer action in cleaning operation is explained. See also *Ceram. Abs.*, **10** [11], 757 (1931). E.J.V.

Economy in sandblasting process. CHARLES BOULTMAN. *Ceram. Ind.*, **17** [4], 268–70 (1931).—Sandblasting and steel-grit blasting in the enameling industry have been carried on with a disregard of cost and efficiency. B. has compiled data from practical applications of ceramic blasting. He discusses the abrasives and compares costs of sand and steel grit. The latter has been found much more economical. Types or methods of blasting are described and costs shown. Manual-room blasts, automatic-table blast, barrel-type blasting, and twin-room type blast are included. De-enameling is also mentioned. The desirability of modernized blasting methods is emphasized. W.W.M.

Salvaging defects by de-enameling. ANON. *Ceram. Ind.*, **17** [4], 295–300 (1931).—A history of the de-enameling process, dating back to 1894, is given in the form of patents and briefs from articles. W.W.M.

Operating a sand-blast department efficiently. F. A. EBELING. *Ceram. Ind.*, **17** [4], 271–72 (1931).—The factors affecting sandblasting are discussed. Tabulations of sand-blast department production and operations are suggested. A description of a blasting installation, using rotary tables and a cabinet, is given with illustrations. The importance and cost of the compressed air are emphasized. W.W.M.

Removing enamel from enameled copper wire. ANON. *Emaillewaren-Ind.*, **8** [31], 245 (1931).—Enameled copper wire is not covered with an ordinary enamel, a fusing product, but with an enamel fired at a high temperature. For removing such a layer the wire is fired and then pickled for several seconds in nitric acid or a mixture of nitric and sulphuric acid. M.V.K.

Fuel economy by use of light grates. W. GREINER. *Sprechsaal*, **64** [39], 718–19 (1931).—Heat balances as well as longer life and smaller costs emphasize the use of light grates for enamel plants instead of the heavy grates usually applied. W.M.C.

Porcelain enameling furnaces. I. ANON. *Better Enameling*, **2** [6], 11–48 (1931).—A muffle-type furnace and auxiliary equipment are described. **II.** *Ibid.*, **2** [7], 6–11 (1931).—A general description is given of the rotary, straightaway, duplex straightaway, and U-type of continuous furnaces with accompanying equipment. W.C.O.W.

New rubber lining for pickling tanks. B. F. GOODRICH RUBBER CO. *Metal Cleaning & Finishing*, **3** [9], 763–64 (1931); see article by H. E. FRITZ, *Ceram. Abs.*, **9** [12], 1026 (1930). E.J.V.

PATENTS

Flexible vitreous coating for metals. HENRY C. MILLIGAN. U. S. 1,827,536, Oct. 13, 1931. The method of coating steel and iron sheets with enamel which consists in cleaning the surfaces of the sheets with pickling solution containing iron sulphide, coating the sheets with metal oxides and silicates, and then submitting the coated sheets to a high temperature to thoroughly fuse the coating and weld it upon the sheets.

White enamel. VEREINIGTE CHEMISCHE FABRIKEN KREIDL HELLER & CO. Ger. 529,056, April 29, 1928. A F-free enamel for coating foil, etc., by the wet method consists of basic compounds and fusible acids or salts. The example mentions an enamel containing borax, feldspar, saltpeter, soda, calcspar, quartz, and a turbidity-inducing agent consisting of ZrO_2 and $NaNO_3$ or HCOONa. (*C.A.*)

Glass

Strength of glass as affected by casing. JAMES BAILEY. *Jour. Amer. Ceram. Soc.*, **14** [11], 811–19 (1931).

Apparatus for determining annealing constants of glass. DONALD E. SHARP, JAMES BAILEY, AND IRVING HYMAN. *Jour. Amer. Ceram. Soc.*, **14** [11], 820–26 (1931).

Studies on the etching of glass. W. S. KAHLSON. *Jour. Amer. Ceram. Soc.*, **14** [11], 827–32 (1931).

Weathering and iridescence of some ancient Roman glass found in Cyprus. A. W. LAUBENGAYER. *Jour. Amer. Ceram. Soc.*, **14** [11], 833–36 (1931).

Effect of heat treatment on ultra-violet transmission of special glasses. A. Q. TOOL AND R. STAIR. *Ceram. Ind.*, **17** [3], 205–206; [4], 313–14 (1931); *Amer. Glass Rev.*, **50** [48], 12 (1931); for abstract see *Ceram. Abs.*, **10** [11], 765 (1931).

Insulation of Pyrex glass after heating *in vacuo*. J. H. MITCHELL. *Phil. Mag.*, **11** [71], 748–53 (1931).—Tests were made on the electrical resistance of Pyrex at different temperatures at different degrees of heating in vacuum. The glass is heated at a steady temperature for thirty minutes and allowed to cool for about sixteen hours, the conductivity being noted before and after heating. The heating is then repeated at higher temperatures. In this way it is found that after heating to temperatures of 250 to 300 °C there is a decrease in the conductivity of the glass, but after heating at temperatures of 350 to 400 °C there is a marked increase in conductivity. The pressures are below 0.1 mm. mercury. The mean increase in conductivity at these higher temperatures is 23 times the original value. It is observed that a wash with hydrofluoric acid restores the conductivity and thus shows that the permanent increase in conductivity of a specimen after vacuum heating is a surface effect. It is postulated that this is probably due to some chemical change in the outer layers of glass connected with the gas evolution which occurs under these conditions. J.T.L.

Cohesion of quartz fibers. G. A. TOMLINSON. *Phil. Mag.*, **10,** 541–44 (1930.)—T. reviews some work of Stone on the adhesion of glass beads and comments on Stone's conclusion that adhesion is caused by absorption of water vapor to the surface of the glass beads. To test this hypothesis he repeated his earlier experiments on the cohesion of quartz fibers but in carefully dried air, and in addition to this, tests were made in a vacuum in which the fibers were heated to 140 °C. Cohesion takes place under these conditions but is destroyed by the admission of moisture, showing that this effect is not due to surface tension of absorbed water films on the fibers as Stone suggested. Additional experiments were performed by rubbing metals on the surface of the glass. A tenacious film of metal is gradually built up which T. concludes is united to the glass by cohesion bonds comparable in tenacity to those existing in the interior of the solid. J.T.L.

Production of residual double refraction by pressure in certain glasses at atmospheric temperature. F. C. HARRIS. *Phil. Mag.*, **11** [71], 745–48 (1931).—It has been observed that glasses allowed to cool under pressure from near their softening point acquire a double refraction and that this residual double refraction decreases with time, thus indicating the possibility of producing residual double refraction under atmospheric conditions in glass by subjecting it to large pressure for a long time. Three glasses varying from 16 to 79% lead were investigated for this property. After the pressures were removed considerable double refraction was noted but this all disappeared within one month. The results show that a definite residual retardation is produced in certain glasses at atmospheric temperature by applying pressure for a long period; also for simple glasses containing large amounts of PbO the residual double refraction is produced in less time than for glasses containing smaller amounts of PbO, or, alternatively, in any given time the magnitude of the residual double refraction is greater for glasses con-

taining large amounts of PbO than for those containing small amounts. In one glass containing a large amount of lead oxide (64.4%) the presence of other constants seem to counteract the effect of lead. In no case was there any observed increase in the double refraction during the time the load was left on. J.T.L.

Transparency of glass in ultra-violet, visible, and infra-red regions. M. FRITZ-SCHMIDT, G. GEHLHOFF, AND M. THOMAS. *Z. tech. Physik*, **11**, [8], 289–326 (1930); *Ceramics & Glass*, **7** [2], 33–34 (1931).—The experimental work was done on glasses with a composition changing systematically. In the basic glass of the composition SiO_2 82% and Na_2O 18%, the silicic acid was partially substituted by the following oxides: (1) *noncoloring oxides*, (*a*) two-valent: MgO, CaO, ZnO, BaO, PbO; (*b*) three-valent: B_2O_3, Al_2O_3, As_2O_3, Sb_2O_3; (*c*) four-valent: ZrO_2, TiO_2. (2) *Coloring oxides*. (*a*) Oxides coloring into yellow: CeO_2, U_3O_8; (*b*) oxides coloring into green: Fe_2O_3 or FeO, Cr_2O_3, V_2O_5; (*c*) oxides coloring into blue: Co_2O_3, CuO; (*d*) oxides coloring from red to blue: Mn_2O_3 or MnO, NiO. Glasses composed of 3 components, 80% SiO_2 + alkali and 20% B_2O_3 or PbO, and a series of glasses composed of 4 components, 65% SiO_2, 15% Na_2O + K_2O, and 20% BaO, were investigated in order to study the influence of alkalis. The results are as follows: (1) *Noncolored glasses*. (*a*) Quartz glass possesses the highest transparency in the infra-red region and other regions. The transparency is complete up to 3.5μ; at 5μ it is insignificant. A curve shows a low absorption at 3.3μ and 4.3μ. (*b*) Univalent glass-forming oxides in boron glasses produce a high transparency in the ultra-violet region, the transparency changing slightly with an increase in alkalis. Soda glasses are more transparent than potassium glasses. The absorption limit for potassium glasses is from 225 to 236$\mu\mu$ (with 10 to 30% K_2O) and for soda glasses, 219$\mu\mu$ for every concentration. The results with lithium glasses are uncertain (devitrification). A considerable loss of transparency begins at 2.6μ in the infra-red region. At 2.9μ and 3.5μ the bands of absorption are weak. With an increase in the alkali content, absorption increases. In lead glasses the band is clearly marked out at 3.6μ and increases with increase of alkali content. In baryta glasses (4 components) differences in absorption are slight. The bands of absorption are at 3.6μ. (*c*) Two-valent glass-forming oxides. The basic glass (82% SiO_2 and 18% Na_2O) has the highest transparency (220$\mu\mu$ at 1 mm. thickness) in the ultra-violet region. The transparency decreases with an increase in the RO content. The greatest absorption appears in lead glasses where 2% PbO changes the limit of absorption up to 270$\mu\mu$. CaO and BaO glasses have the best transparency. Magnesium and zinc glasses are less transparent. The basic glass, as all silica glass, shows a decrease in transparency beginning at 2.6 and 4μ in the infra-red region. The minimum of transparency is between 2.6μ and 4μ with two maximums at 2.9μ and 3.6μ. In general, with the introduction of RO, both bands of absorption tend to expand and approach each other and in a glass with a high content in RO they unite forming one maximum of transparency at 4μ. (*d*) Three-valent glass-forming oxides. The increase of alumina shows a marked decrease of transparency (with 10% alumina the limit is 238$\mu\mu$). The substitution of SiO_2 by B_2O_3 has small influence, but the transparency is somewhat lowered. Glasses containing arsenic are similar to those containing alumina (5% As_2O_3 have a limit near 250$\mu\mu$). Antimony, like lead, strongly decreases transparency (the limit of transparency with 5% Sb_2O_3 is 280$\mu\mu$; with 35%, 320$\mu\mu$). Both bands of absorption (2.9μ and 3.6μ) join together in alumina glasses in the infra-red region. Boron glasses are characterized by a strong decrease of transparency. Both bands appear distinctly and do not join. Glasses with Sb_2O_3 and As_2O_3 do not show any peculiarities. Antimony glasses have a small decrease in transparency at 1μ. (*e*) Four-valent glass-forming oxides. Zirconium glasses are similar to alumina glasses in the ultra-violet region (15% ZrO_2, limit 250$\mu\mu$). TiO_2 absorbs the most. One to 2% TiO_2 produces an absorption corresponding to that produced by 10% PbO or 5% Sb_2O_3

(with 20% TiO_2, the limit of absorption is 340$\mu\mu$). Titanium glasses have a high transparency up to 4μ in the infra-red region. (2) *Colored glasses.* (*a*) Oxides coloring into yellow: CeO_2 strongly lowers transparency in the ultra-violet region. The limit of absorption with 1% CeO_2 is 330$\mu\mu$; with 5% it is 355$\mu\mu$. A low absorption in the violet part is seen in the visible region with a small CeO_2 content. The influence of uranium is similar to that of cerium in the ultra-violet region (with 5% U_3O_8, the limit of absorption is 350$\mu\mu$). With an increased U_3O_8 content, a strong increase of absorption in the blue-violet part of the spectrum is seen in the visible region. At 0.9μ and 1.5μ, sharp bands of absorption are observed in the infra-red region; these bands become deeper with an increase in U_3O_8 content. (*b*) Oxides coloring into green: Oxides of iron are characterized by a strong absorption in all regions of the spectrum; 0.1 Fe_2O_3 changes the limit of absorption of the glasses from 220 to 295$\mu\mu$ in the ultra-violet region. Iron oxide absorbs more than protoxide in the ultra-violet region and in the visible part of the spectrum generally. With a large content of oxides, a maximum transparency is formed at 550 to 560$\mu\mu$ as a result of the absorption in the red and violet parts. Bands of absorption at 630 to 640$\mu\mu$, 710$\mu\mu$ and 48$\mu\mu$ were observed with a reduced fusion (FeO). Oxides of iron and especially protoxides promote a strong absorption of rays in the infra-red region. An almost complete absorption is observed with a reduced fusion and 15% iron oxide; with 25% and oxidized fusion, the glasses transmit an important quantity of infra-red rays. In glasses containing iron oxide, the band of absorption is well marked out at 1.1μ; the maximum transparency is defined at 4μ. Chromium oxide produces a strong absorption in the ultra-violet region. Chromium glasses are characterized by a large band of absorption in the regions of 340 to 400$\mu\mu$. Glasses with 0.2 or 0.4% Cr_2O_3 are already colored into intensive yellow-green and green colors corresponding to a maximum of transparency at 550 to 560$\mu\mu$. A sharp absorption of extreme violet rays is observed and all the violet and a part of the blue rays, with an increase of chromium oxide content; the transparency decreases in the other parts of the visible spectrum at the same time. The transparency is good in the extreme red part of the spectrum. A wide band of absorption is sharply marked out at 650$\mu\mu$. In the ultra-violet region, the curve of absorption does not differ from the curve of the basic glass and does not change with an increased Cr_2O_3 content. Vanadium oxide lowers the transparency in the ultra-violet region in the same manner as Cr_2O_3. The glass is colorless with 0.5 to 1.0% V_2O_5 and corresponds in its power of absorption in the ultra-violet region to glasses with 5% CeO_2 or 25% TiO_2. In the visible spectrum, absorption appears in the violet and blue and extends partly to the green part of the spectrum with an increased V_2O_5 content. A band is sharply defined at 1μ which widens and deepens in the infra-red region with an increased V_2O_5 content; otherwise the curve corresponds to the curve of the basic glass. (*c*) Oxides coloring into blue: Oxides of cobalt and copper lower the transparency in the ultra-violet region. The absorption of copper glasses is much larger (with 5% CuO the limit of absorption is 330$\mu\mu$; with 5% CoO, 280$\mu\mu$). Glasses with a small CoO content absorb mainly in that part of the visible region from 550 to 650$\mu\mu$. Bands of absorption appear at 540, 600, and 640$\mu\mu$. Transparency is high in the red and blue parts of the spectrum. With an increased CoO content, transparency strongly decreases in the entire visible spectrum. Copper glasses with a low CuO content are colored into blue corresponding to the wave length of 450$\mu\mu$. The color changes into blue-green with an increase in CuO content and the maximum transparency moves to the green part. At the same time, the absorption increases rapidly for all the other wave-lengths. Cobalt glasses are similar to iron glasses in the infra-red region. With 0.1% CoO a band of absorption appears at 1.5$\mu\mu$ which widens with an increased CoO content and the maximum transparency is formed at 4$\mu\mu$. In the region of short infra-red rays, glasses with CuO are character-

ized by a band of absorption beginning in the red region. Beginning with 2.5$\mu\mu$, the absorption corresponds to the absorption of the basic glass. (*d*) Oxides coloring into red and blue-violet: Manganese glasses were fused in oxidized (MnO_2 + saltpeter) and reduced (MnO + sugar) conditions. Glasses containing Mn_2O_3 absorb more in the ultra-violet region (the limit of absorption with 5% MnO is 280$\mu\mu$; with 5% Mn_2O_3, 300$\mu\mu$). Mn_2O_3 also absorbs more in the visible part. The character of curves for both degrees of oxidation are similar. The band of absorption appears at 490$\mu\mu$ which corresponds to the minimum transparency in the blue-green and green parts of the spectrum. With the increase of the content in oxides, the transparency rapidly diminishes for all waves and causes a complete absorption of visible light. In the infra-red region, all the glasses do not differ from the basic glass. Nickel glasses possess a high transparency in the ultra-violet region which diminishes very little with an increase of the nickel oxide content. For glasses transmitting ultra-violet rays, NiO is better than CoO as it absorbs ultra-violet rays less than CoO and possesses a wide absorption in the visible part of the spectrum (from 450 to 650$\mu\mu$). The color of nickel glasses is from brown to red-violet and depends on the thickness of the sample. Glasses containing nickel are similar to those containing iron in their transparency in the infra-red region. Nickel glasses as well as iron glasses absorb the infra-red rays most strongly. Two bands deepen at 1.1μ and 2.2μ with an increased NiO content and produce a maximum transparency at 1.5μ and 4.2μ. The spectrums of all glasses investigated are illustrated by 59 diagrams. M.V.K.

Permeability of glass to ultra-violet rays. P. GILARD, P. SWINGS, AND A. HAUTOT. *Chem. Zentr.*, **102** [11], 1618 (1931); *Bull. sci. acad. roy. Belg.*, **17**, 593–602 (1931); see also *Ceram. Abs.*, **10** [11], 765 (1931). J.G.T.

Physics in the glass industry. F. W. PRESTON. *Glass Ind.*, **12** [10], 197–200 (1931).—The physicist has introduced testing appliances in the bottle and flat glass industries. The annealing process is essentially a physical rather than an engineering process. The knowledge of the physics involved in the melting process is incomplete. The work of the physicist in the electric lamp bulb business, the radio tube field, and the scientific glassware branch has been important. Following the review of the glass industry and the physicist's activities in it, some of the work now being conducted to give more precision to ideas of the "glassy state" is reviewed briefly. E.J.V.

Beryllium glass transparent to X-rays. O. K. BOTVINKIN. *Ceramics & Glass*, **7** [4], 25 (1931).—B. describes investigations made to prepare beryllium glass transparent to X-rays. The glass composition is 80% B_2O_3, 10% LiO_2, and 10% BeO, and its specific gravity 2.20. Such a glass of 0.4 mm. thickness has a transparency of 99.08%. M.V.K.

Effect of mercuric iodide and ammonium chloride on glass. CLARA E. MILLER. *Jour. Phys. Chem.*, **35** [10], 2985–92 (1931).—Measurements of vapor pressure of toluene in a fused Pyrex bulb and in the same bulb after heating with mercuric iodide show extensive adsorption in the latter case. This effect is atrributed to the fact that mercury iodide attacks the surface of the glass leaving it coated with a layer of silica. Mercuric iodide reacts with soft glass at a high temperature to produce a soluble iodide and with Pyrex to form a black compound whose identity has not been determined. Adsorption measurements show that ammonium chloride has a strong effect in roughening the surface of glass. The corrosive action of these reagents is attributed to the existence of free sodium ions in the glass and is shown to render glass an unsuitable substance for use in adsorption vessels where adsorption of polar compounds at high temperatures is to be studied. G.R.S.

Ultra-violet absorption of certain minerals. NORA M. MOHLER. *Amer. Mineralogist*, **16** [7], 300–304 (1931).—Absorption coefficient is defined by the equation I =

$I_o e^{-\mu d}$, in which I_o is the intensity of incident light, I that of the transmitted light, μd is absorption coefficient, μ the absorption coefficient per cm., and d the thickness. Curves are given showing relation of absorption coefficient to wave-lengths in $\mu\mu$ for the following substances: amethyst, opal, smoky quartz, agate biotite, and muscovite. G.R.S.

Homogeneity of the batch. F. H. ZSCHACKE. *Sprechsaal*, **64** [35], 645–48; [36], 662–65 (1931).—Disintegration of a batch which was thoroughly mixed by hand or machinery was supposed to be impossible as outlined in a paper by Z. (see *Ceram. Abs.*, **8** [6], 400 (1929)). Several authors, however, believe that disintegration of a batch is possible. A batch was mixed by hand in the proper way to detect any disintegration. Curves show the mixing effect of a certain batch. No disintegration could be detected. The opposite results by other authors are supposed to be caused by a mistake in taking samples, by disintegration within the sample itself, or by disintegration which may take place in a standing batch. W.M.C.

Glass formation with application of sodium silicate. I. I. KITAIGORODSKY AND N. SOLOMIN. *Chem. Zentr.*, **102** [6], 892 (1931).—Formation of silicates in which entire Na_2O is introduced as silicate is faster than in the case of the introduction of Na salts. This is especially true at 800 to 1000°. The advantage is clearly seen from comparison with sulphate which melts with difficulty and affects the refractory brick. J.G.T.

Use of ammonium sulphate as accelerating agent in glassmelting. MICHAEL PARKIN, W. J. A. WARREN, AND W.E. S. TURNER. *Nat. Glass Budget*, **47** [20], 18 (1931); for abstract see *Ceram. Abs.*, **10** [10], 684 (1931). E.P.R.

Calculation of the tensile strength of glass. O. KNAPP. *Glashütte*, **60**, 364 (1930); *Jour. Soc. Glass Tech.*, **14**, 290–91*A* (1930).—For the purpose of calculation of the tensile strength, it is assumed that this is an additive property dependent on the silicates present in the glass, and that when the SiO_2 content is 50 to 66.6 molecules per cent the oxides are present as monosilicates and the excess SiO_2 is present as free oxide. Similarly, when the SiO_2 content is 66.6 to 75, or 75 to 80 molecules per cent the oxides are present as di- or tri-silicates. The tensile strength of such a glass is then readily calculated by the use of factors deduced from the data for tensile strength published by G. Gehlhoff and M. Thomas (see *Ceram. Abs.*, **7** [2], 72 (1928)). A table shows the value for the tensile strength of 22 of Gehlhoff and Thomas' glasses as calculated (*a*) by A. Winkelmann and O. Schott's factors, (*b*) by Gehlhoff and Thomas' method, and (*c*) by the above-mentioned factors. The percentage deviation of each of these from the observed value is shown. Methods (*b*) and (*c*) are fairly accurate but (*a*) gives rather high values. (*C.A.*)

Glass. ALBERT GRANGER. *Céram. Verrerie*, 497–99, 551–54, 607–10 (1930).—The crystalline structure of glass and the arrangement of molecules or molecular phenomena involved are discussed. The devitrification of glass is considered from a physical viewpoint. As a liquid in unstable equilibrium, certain conditions prevent its crystallization. For devitrification the mass must contain one or more centers of crystallization and these centers must develop so as to imply an appreciable rapidity of crystallization. See also *Ceram. Abs.*, **10** [6], 415 (1931). (*C.A.*)

Solubility of R_2O-PbO-SiO_2 glass in water. KOZO TABATA, KENSUKE YEGAMI, AND SHIZUTA MORIYASU. *Proc. World Eng. Cong.* [Tokyo, 1929], **31**, 409–16 (1931); for abstract see *Ceram. Abs.*, **9** [2], 90 (1930). (*C.A.*)

Studies in composition of fluoride turbid glasses. OSKAR KNAPP. *Chem. Zentr.*, **102** [6], 892 (1931).—K. determines the effect of the proportion of Na : Ca in glass on the formation of NaF or CaF_2. See also *Ceram. Abs.*, **10** [9], 631 (1931). J.G.T.

Glass containing nepheline. A. I. MOTCHALOV. *Ceramics & Glass*, **7** [5], 11–13 (1931).—M. describes tests on the manufacture of glass with nepheline from the Ural

Mountains. The composition of nepheline is 44% SiO_2, 33.2% Al_2O_3, 15.1% Na_2O, and 7.66% K_2O. The results are tabulated and show that nepheline can be used successfully for the production of window glass. See also *Ceram. Abs.*, **10** [5], 338 (1931). M.V.K.

Accelerating the fusion of glass. A. I. MOTCHALOV AND CHOMENKO. *Ceramics & Glass*, **7** [5], 14 (1931).—Investigations show that an addition of 5% of $(NH_4)_2SO_4$ (of the weight of the batch) to a glass batch accelerates its fusion about 30 to 36%, and the quality of the glass is not lowered. A greater amount of $(NH_4)_2SO_4$ increases the fusing time. M.V.K.

Glass of volcanic ash. ROMATCHA. *Ceramics & Glass*, **7** [5], 5–11 (1931).—Tests were made with additions of volcanic ash to the glass batch (60% from the weight of sand) which showed that the ware obtained had a greater mechanical stability due to an increase of the alumina content. With a greater admixture of ash, the glass becomes more viscous and requires a higher temperature for annealing as lower temperatures cause defects in the glass in the form of "transparent stones." The glass obtained has a milky color. M.V.K.

Transparency of window glass. N. A. REMIZOV. *Ceramics & Glass*, **7** [5], 3–5 (1931).—The degree of glass transparency for infra-red rays depends on the length of the waves. The shortest infra-red rays with a wave-length from 1 to 1.5 micron are the most harmful to vision. The transparency of glass depends on its thickness and on its composition; chiefly on its titanium oxide (TiO_2) and iron oxide (Fe_2O_3) content. Its transparency diminishes with the increase of the Fe_2O_3 and TiO_2 contents in the glass. M.V.K.

Glass and glazing. I. DAVID B. EMERSON. *Pencil Points*, **12** [9], 713–16 (1931).—Glass does not antedate the Christian Era. It was known about the 4th or 5th Century and put into general use in the late 13th Century. It was first made in the U.S. at Jamestown in 1608. Plate glass was invented in France by Perreau in 1687 and established in the U.S. in the 1880's. The different kinds of glass and methods of manufacture are described. **II.** *Ibid.*, **12** [10], 789–91 (1931).—The manufacture and decorating of prism and mirror glass are described. E.B.H.

Discovery in making glass. P. O. DAVIS. *Mfrs. Rec.*, **99** [20], 44 (1931); see also abstract by C. A. BASORE, *Ceram. Abs.*, **10** [9], 632 (1931). E.P.R.

Glass problems to be considered by the optician. J. FLUEGGE. *Sprechsaal*, **64** [39], 716–18 (1931).—F. points out glass properties which are undesirable for making simple lenses. W.M.C.

Legal testing of glasses for medicines, etc. L. KROEBER. *Sprechsaal*, **64** [37], 682–83 (1931).—A review is given of the new legal directions introduced in Germany in July, 1931, regarding testing of glasses and phials for medicines. W.M.C.

Lightning arrester of glass. ANON. *Nat. Glass Budget*, **47** [23], 12 (1931).—Not only does this arrester protect the radio against lightning damage, but it also dissipates accumulatvei static charges from the antenna system. E.P.R.

Carborundum in the service of the glassworking industry. VICTOR LITSCHER. *Diamant*, **52** [25], 405–406 (1930).—For polishing and general abrasive treatment of glass the silicon carbide best suited is of 60- or 70-mesh size. Washing and screening removes the finely ground glass. A method of cutting glass with the use of 70- or 80-mesh silicon carbide on an iron wheel running at about 350 r.p.m. is described. E.J.V.

Chromium plating in the glass industry. N. H. MCKAY. *Nat. Glass Budget*, **47** [19], 3 (1931).—Applications involving resistance to abrasion have been particularly successful in the field of small tolerance or low permissible wear because chromium plating on these surfaces has greatly increased their life. Chromium plating is widely

used in the glass industry for (1) heat resistance, (2) corrosion resistance, and (3) reclamation work. E.P.R.

Soldering glass to metals. WESTINGHOUSE ELECTRIC & MFG. CO. *Ceram. Ind.*, **17** [4], 304 (1931).—A metallic glaze is used to form a molecular bond between the glass and the metal. W.W.M.

Manufacture of nonbreakable glass. E. C. GOUREVITCH. *Ceramics & Glass*, **7** [5], 16–21 (1931).—The manufacture of nonbreakable glass according to the patent literature of U.S. and Europe is reviewed and discussed. M.V.K.

Safety glass as standard auto equipment. WILLIAM LETTS. *Nat. Glass Budget*, **47** [6], 10 (1931).—L. predicts that within two years the use of safety glass as standard equipment in automobiles will be universal in Europe. See also *Ceram. Abs.*, **10** [6], 419 (1931). E.P.R.

"No-flake" glass cutter. FLETCHER, TERRY CO. *Nat. Glass Budget*, **47** [20], 11 (1931).—Laminated or safety glass must be cut on both sides before it can be fractured. The head of the "no-flake" cutter is equipped with a felt pad. Oil is supplied to this pad through a small oil reservoir and when the pad is saturated with light oil it swabs a cutting path with oil, cleaning the glass ahead of the wheel and allowing it to cut without heating, flaking, or blistering. E.P.R.

Architectural glass. ANON. *Amer. Glass Rev.*, **50** [49], 13–14 (1931).—To give this product the tensile strength and ability to withstand all sorts of weather conditions, the same Pyrex glassware from which insulators are made is used in its composition. E.P.R.

Glass and steel structures in Chicago. ANON. *Ceram. Ind.*, **17** [4], 305 (1931).—An apartment building, a theater, and probably an office building with exteriors wholly of steel and glass will be under construction in Chicago by the first of 1932. W.W.M.

Glass as building material in Germany. ANON. *Amer. Glass Rev.*, **50** [50], 23–24 (1931); *Ceram. Ind.*, **17** [4], 301–304 (1931).—It is estimated that 50% of all building in Germany at present is of glass and steel construction in which flat glass plays an important part. See also *Ceram. Abs.*, **10** [8], 557 (1931). E.P.R.

White glass plant at Medias, Rumania. D. WATSCHINGER. *Sprechsaal*, **64** [38], 701–704 (1931).—The new plant of the Vitrometan Company is described. Two Amsler-Morton tank furnaces and a Schwaller furnace for 8 glass pots are installed. Several plans are given showing details of arrangement of machines and buildings. W.M.C.

Glass industry in France. EDWIN C. KEMP. *Commerce Repts.*, No. 40, pp. 42–43 (1931).—The manufacturing of glass in the Bresle Valley has been in existence since the 10th Century. While normally 4000 employees are engaged, hardly one-half that many are now employed. Although both round and flat glass were formerly manufactured, present production is limited to medicine and perfumery bottles with some vases and novelty articles. E.J.V.

Osaka's glassware. ANON. *Commercial Osaka*, **31**, 2–4 (June, 1931).—Osaka, the industrial center of Japan, is the greatest center for glass manufacture except plate glass. The export trade, which is to Asiatic countries, has declined 50% lately. H.H.S.

Glass cooling with cooling containers. S. ROLF. *Chem. Zentr.*, **102** [11], 1618 (1931).—Glass products to be cooled were placed in a kiln in a sheet-iron container, a clay pot with a sheet-iron cover, and an insulated sheet-iron pot with a sheet-iron cover. At 500 to 600° they were taken out and the temperature was measured. The advantages of the insulation are small. J.G.T.

Properties of lining material of glass baths. H. SCHILLING. *Chem.-Ztg.*, **55** [72], 691 (1931).—Silicic acid of the glass combines with the basic cement and loosens the

plates. To prevent this it is necessary to bring the composition of the cement near that of the bath. J.G.T.

Using coke kiln gas in the German glass industry. ANON. *Glashütte*, No. 20 (1931); *Ceramics & Glass*, **7** [2], 31 (1931).—Ways of using coke kiln gas in the German glass industry are described. The quality of the glass and the durability of kilns are not affected. M.V.K.

Melting tank furnace. R. L. FRINK. *Amer. Glass Rev.*, **51** [1], 14 (1931).—F. is conducting experiments with a new type of glassmelting furnace known as the "Frink gravity furnace." It is a small tank mounted on a track and is said to melt a ton of glass with the consumption of only 1000 cu. ft. of gas. The new device will melt glass more quickly than other types. One of the furnaces is used with the forming machine. "Frinkite," a refractory substance, is used largely in the construction of the furnace. E.P.R.

Annealing by electric heat. R. M. CHERRY. *Ceram. Ind.*, **17** [4], 273–75 (1931).—C. gives the advantages of electrically-heated leers. Illustrated. W.W.M.

Temperatures in a direct pot furnace. R. D. CHANDORKAR. *Jour. Indian Ceram. Soc.*, **3** [1], 34–38 (1931).—Temperatures were measured with fixed focus radiation pyrometers and checked by a Pt couple. The furnace and flue are briefly described. Average temperatures were as follows: at the time of charging, 1120°C; when the first charge has melted and before adding the second charge, 1185°C; when the pot is opened, 1280°C; when the metal is being rolled and worked on, 730°C; when the pot is empty, 1025°C. A.A.

Acid or basic building stone for glassmelting furnace. ERICH FELSNER. *Chem. Zentr.*, **102** [6], 892 (1931).—Natural sandstone has satisfactory qualities and long life if sufficiently dried before use. J.G.T.

Manufacture of rolled plate. XIII. ERNST LUTZ. *Glass Ind.*, **12** [10], 204–207 (1931).—Some of the patented devices used in the polishing of plate glass are described. Part of the apparatus is for a more or less continuous process. Illustrated. For Part XII see *Ceram. Abs.*, **10** [11], 768 (1931). E.J.V.

BOOK

Supplementary Volume to "The Laboratory Book of the Glass Industry." (Ergänzungsband zum Laboratoriumsbuch für die Glasindustrie.) LUDWIG SPRINGER. Wilhelm Knapp, Halle, 1931. 149 pp. 12 Rm. Reviewed in *Keramos*, **10** [18], 477 (1931); *Amer. Glass Rev.*, **50** [50], 14 (1931).—In the first part S. discusses investigations on raw materials. The second part is devoted to the treatment of the batch, testing, and the fusion sample. The third part contains researches on finished products, chemical analyses, testing of chemical properties, physical investigations and researches, and the correction of defects of glass. The fourth part deals with laboratory work for preparing refractory materials and improving the quality of glass, and the last part discusses fuel and firing control. See also *Ceram. Abs.*, **9** [10], 837 (1930). M.V.K.

PATENTS

Composite plunger for glass feeders. WILLIAM T. BARKER, JR. U. S. 1,780,550, Nov. 4, 1930. In a glass feeder, a composite flow-controlling plunger comprising a tubular outer member and an inner core member adapted for adjustment longitudinally of each other, the core member fitting the tubular member to permit relative longitudinal movement of the members but to substantially prevent passage of molten glass between the members.

Automatic feeder for glass-molding machines. TANCREDO DE BIASE. U. S. 1,824,197, Sept. 22, 1931. An automatic feeder comprising an open-topped vessel to receive molten glass having a lateral discharge opening, a needle mounted above the

open top of the vessel, means for positively tilting the vessel downward about a horizontal axis at regular intervals into position to align the discharge opening with the needle, means for imparting a vertical reciprocating movement to the needle so as to project its lower end through the opening at the end of the down-stroke and thereby extrude a gob of glass, and means for severing the extruded gob, the needle, during its up-stroke, drawing back through the discharge opening into the interior of the vessel, the remains of glass adhering to the needle at the moment when the gob is severed, the remains staying in the vessel while the latter occupies its nondischarging position.

Making glass cylinders. NICHOLAS KOPP. U. S. 1,824,216, Sept. 22, 1931. The method of surfacing a hollow article while in a pliable condition, consisting in subjecting a surface of the glass to combined rectilinear pressure and pressure in a direction at an angle thereto through the movement of a body against the same of different external shape to the initial shape of that portion of the article engaged by the body.

Grinding, smoothing, and polishing glass. CHARLES HIBON. U. S. 1,824,347, Sept. 22, 1931. In a surfacing device for the continuous grinding, smoothing, and polishing of glass, the combination of a traveling support for the glass to be surfaced, a series of abrasive members mounted above the support, each member consisting of elements dissimilar in coverage which extend across the support, the dissimilar elements of adjacent members being arranged in reverse order.

Manufacture of wire glass. LEANDER N. POND AND JOSEPH H. LEWIS. U. S. 1,824,365, Sept. 22, 1931. The process which comprises feeding molten glass to and through a forming pass between rolls, feeding wire to the molten glass in a direction at a substantial angle to the direction of movement of the wire through the pass, and determining the position of the wire in the glass sheet by varying the speed or drive on the wire in relation to the speed of the forming rolls.

Manufacture of wire glass. LEANDER N. POND. U. S. 1,824,366, Sept. 22, 1931. The combination with forming rolls having a forming pass between them, means for feeding glass to the forming pass, a netting feed roll adjacent to the upper forming roll, the two having a space therebetween for the passage of netting, the axis of the netting feed roll being in a horizontal plane below that of the upper forming roll, and the netting feed roll having its center swelled in respect to its ends.

Making sheet glass. SAMUEL A. FORTER. U. S. 1,824,474, Sept. 22, 1931. Apparatus including a container having at least two spaced machines with a chamber therebetween, at least one side of the chamber having a pair of inlet ports for heating gases and having an outlet port therebetween.

Feeding molten glass to a rolling apparatus for producing a continuous glass strip. ERNEST BRISTOW LE MARE AND FREDERIC BARNES WALDRON. U. S. 1,824,490, Sept. 22, 1931. In apparatus of the type described, the combination with a gate and two members connected to the gate near its ends, of a raising and lowering device engaging each of the members, comprising a worm and worm wheel, a spherical block within which the worm wheel is rotatable, a spherical seating for the block, a sleeve mounted coaxially within and angularly fast to the worm wheel but movable axially thereof, a nut threaded on the upper end of the sleeve constituting an adjustable stop for the downward movement of the sleeve, a spring constantly tending to depress the sleeve to the limit permitted by the stop and a nut fast to the sleeve and in threaded engagement with the member, and a shaft carrying the two worms.

Rotary machine for manufacturing glass hollow ware, etc. ALEXANDER FRANCIS MCNISH. U. S. 1,825,082, Sept. 29, 1931. In a glassworking machine, the combination of a central support, a mold carrier revoluble about the support, a member oscillatory about the support, means for oscillating the member through part of a circle, means for connecting the carrier and member in one direction of oscillation of the member to move

the mold carrier forward, means for arresting the mold carrier during the return movement of the member, a series of separable molds carried by the carrier, mechanism on the carrier for operating the molds, and devices movable with the member and coöperating with the mechanism to effect the operation of the molds during the return movement of the member.

Means for delivering charges of molten glass. MICHAEL J. OWENS. U. S. 1,825,416, Sept. 29, 1931. The combination of a receptacle to contain molten glass having an outlet orifice in the bottom thereof, a regulator projecting downward into the glass above the orifice, means to reciprocate the regulator vertically, a forming cup, means to periodically move the cup into position beneath the orifice in synchronism with the movements of the regulator, means to exhaust the air from the forming cup and thereby shape a mass of glass therein, means for withdrawing the cup away from the mass of glass and from the position beneath the orifice, thereby leaving the mass suspended from the walls of the orifice, and means for severing the mass after the cup is withdrawn.

Making plate glass. ROBERT L. CLAUSE. U. S. 1,825,853, Oct. 6, 1931. In apparatus for making sheets of glass, a roller leer, vertically movable lifting bars interspersed between the leer rolls and lying in raised position with their upper sides above the rolls and in lowered position having such sides below the tops of the rolls, an intermittent sheet-rolling apparatus in alignment with the leer, and means for raising and lowering the bars.

Severing composite glass sheets, etc. WILLIAM OWEN. U. S. 1,825,886, Oct. 6, 1931. In combination, a machine for cutting curves in sheets of hard material, comprising a thin driven cutting disk, a supporting table, a tray for carrying the sheet to be cut over the table having a depth approximately equal to the thickness of the sheet and provided with a template lying over the sheet and holding it down, means preventing lateral movement of the sheet in the tray, and a flanged guide roller mounted with its axis of rotation in fixed relation with respect to the axis of rotation of the disk, and adapted to fit over the template bar and guide the tray and sheet carried thereby over the table beneath the disk.

Glass-tank construction. WILLIAM OWEN. U. S. 1,825,887, Oct. 6, 1931. The combination with a tank adapted to carry a bath of molten glass and rolling means at one side thereof for forming a sheet or ribbon of glass, of a clay outlet member between the glass bath and the rolling means provided with a slot extending longitudinally thereof, slotted metal holding members fixed in the outlet member at the ends of the slot, and a lip member of metal mounted in the slot with its ends in interlocking engagement with the slots in the end members, such lip member being positioned to direct the glass from the tank to the pass between the rolls.

Sheet-glass apparatus. KARL KUPFERSCHMID. U. S. 1,826,006, Oct. 6, 1931. In sheet-glass apparatus, a deputer embodying a selected member, means arranged internally thereof for heating it, and insulating means also disposed within the member.

Transferring glass parisons. KARL E. PEILER. U. S. 1,826,019, Oct. 6, 1931. The method comprises inverting the blank by force applied to the neck of the blank and varying the speed of the inverting movement to cause the centrifugal force developed by the inverting movement to balance the action of gravity to any desired extent throughout the inverting movement, thereby preventing lateral distortion of the blank through the action of gravity during the inverting movement.

Grading of abrasives for use in continuous glass-grinding machines. FREDERIC BARNES WALDRON AND JAMES HARRIS GRIFFIN. U. S. 1,826,585, Oct. 6, 1931. In apparatus for grading abrasive and supplying it continuously, the combination of a channel along which the mixture to be graded flows, the channel increasing in cross-sectional area from the inlet to the overflow, submerged partitions in the channel forming

tanks in which the different grades of abrasive settle and from which the grades are continuously discharged, and tanks of greater cross-sectional area than the channel extending over a length thereof at the inlet end, in which tanks the channel is formed.

Rolling glass. ARTHUR BRANCART. U. S. 1,827,138, Oct. 13, 1931. In apparatus for the manufacture of glass plates and sheets, the combination of a pair of rolls for rolling glass in a plastic condition, a receiving table, an inclined guide plate between the rolls and the table, the permanent inclination of the plate being such that the glass will not stay thereon, the plate being hollow and having a perforated upper surface, the perforations in the surface being distributed over the whole length thereof, and a gas supply pipe opening into the inside of the plate.

Rolling glass. CLAUDE LOCREILLE. U. S. 1,827,155, Oct. 13, 1931. In a glass-rolling plant, the combination with a glass-annealing furnace of a table in front of the furnace extending at right angles thereto, a base for the table, the base being of greater width than the table, there being a gap between the table and the furnace, a rolling train movable on the base, the rolling train comprising a frame resting on the base on either side of the table, rolls mounted in the frame, a motor carried by the frame, a driving connection between the motor and the rolls, means for moving the frame along the table, a driving connection between the motor and the means, and a guard for closing the gap, the guard being secured to the frame.

Making sheet glass. ROY C. CONN. U. S. 1,827,459, Oct. 13, 1931. The combination with apparatus arranged to draw a glass sheet from a pool of molten glass, of means for preventing an inward movement of the edge of the sheet in the pool comprising a shielding bowl of metal above the surface of the pool, but closely adjacent thereto, and having a slot extending inward from its edge and fitting around the edge of the sheet, the bowl having an opening cut through its walls on each side of the slot adjacent thereto.

Glassmelting apparatus. ALFRED L. HARRINGTON. U. S. 1,827,469, Oct. 13, 1931. In combination, a glassmelting tank mounted for tilting movement about a horizontal axis, provided with a pouring spout, and comprising a collecting chamber and a plurality of reducing chambers extending laterally from one side of the collecting chamber, means for feeding batch into each of the reducing chambers, electrodes in such chambers, means for causing a flow of current between the electrodes through the contents of reducing and collecting chambers to melt the batch and maintain it in molten condition, and means for tilting the tank at intervals to discharge the melted glass which accumulates in the collecting chamber.

Making glass. HARRY F. HITNER. U. S. 1,827,471 and 1,827,472, Oct. 13, 1931. (1) A tank having a melting end and a refining end with an interposed wall extending down into the glass so that the two ends communicate beneath the lower edge of such wall, an outlet for withdrawing molten glass from the refining end of the tank, means for supplying batch to the melting end of the furnace, a metal electrode plate forming a part of the side wall of the tank adjacent the point where batch is supplied and extending in an inclined position downwardly and to the rear from the surface of the glass, a second metal electrode plate forming a part of the bottom wall of the furnace at the outlet of the melting end of the furnace, and means for supplying current to the electrodes. (2) In combination in an electric furnace for making glass, a vertical tank having means for supplying batch to the upper end thereof and for withdrawing the melted glass from the lower end thereof, an electrode contacting with the glass in the lower end of the tank, an arc electrode above the surface of the glass at the upper end of the tank and remote from the side walls thereof, and means for supplying current to the electrodes.

Glass-annealing leer with insulated tunnel. ALAN W. RUSSELL AND HAROLD A. WADMAN. U. S. 1,827,673, Oct. 13, 1931. A leer for annealing glassware comprising a

tunnel formed of a plurality of sections having telescoping end portions, a sheet-metal casing surrounding but spaced from the sections, a plurality of pairs of socket members located respectively on the top and bottom of the tunnel sections and on the inside of the top and bottom of the casing, blocks of low heat conductivity positioned in the sockets to support the tunnel sections and position them with respect to the casing, the sockets extending beyond the blocks in a direction longitudinal of the tunnel to permit maintenance of the blocks in the sockets upon the differential movements of the tunnel sections and the casing, and loose heat-insulating material filling the remainder of the space between the tunnel sections and the casing.

Glassware forming machine. JOSEPH P. BENOIT. U. S. 1,827,698, Oct. 13, 1931. In combination, a neck mold, a partible two-section blank mold arranged in a plane below the neck mold, a horizontally disposed flange at the upper end of each mold section, the flange having a vertical opening therein, a holder for each mold section having a stud extending upwardly through the corresponding opening, mold arms supporting the holders and mold sections and operative to alternately open and close the mold, means whereby the movement of the mold arms inwardly beyond the point necessary to close the blank mold causes upward movement of the holders and blank mold sections, bringing the mold sections and neck molds into sealing contact with one another, and means whereby the relative movement between the mold arms and holders follows a definite predetermined path.

Manufacture of changeant glass. GLASHÜTTENWERKE VORM. J. SCHREIBER & NEFFEN. Brit. 355,887 and 355,899, Sept. 9, 1931.

Cutting flat glass. PILKINGTON BROS., LTD., AND R. C. WILLIAMSON. Brit. 355,928, Sept. 9, 1931.

Manufacture of glassware. UNITED GLASS BOTTLE MFRS., LTD., AND E. A. COAD-PRYOR. Brit. 355,929, Sept. 9, 1931.

Gathering and handling molten glass. Y. BRANCART. Brit. 356,087, Sept. 9, 1931.

Nonsplintering or safety-glass sheets. LAMINATED GLASS, LTD., M. V. BARRY, AND C. H. H. LAMBERTY. Brit. 356,394, Sept. 16, 1931.

Rolling glass in sheets. SOC. ANON DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 356,563, Sept. 16, 1931.

Obtaining graduated tinted glass. A. W. HAWES, E. H. HAWES, AND R. H. BRADSHAW. Brit. 356,832, Sept. 23, 1931.

Leers for annealing glassware. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD. Brit. 356,920 and 357,075, Sept. 23, 1931.

Glassforming machines. C. C. KINKER. Brit. 357,124, Sept. 30, 1931.

Adhesive for glass. ALEXANDER C. NIXON AND MAX UNGER. Can. 313,495, July 21, 1931. An adhesive for glass comprises celluloid scrap 3 to 7, diethylene glycol monoethyl ether 3 to 10, diamyl or dibtuyl phthalate 3 to 10, ethyl acetate 20 to 25, acetone 20 to 25, butyl alcohol 5 to 10, and toluene to make 100%. (*C.A.*)

Heat-resisting glass for daylight effects. WALTER H. RISING. Can. 314,404, Aug. 18, 1931. A borosilicate glass containing an alkaline earth oxide, ZnO, and CoO is rendered heat-absorbing by FeO. The amount of alkaline earth oxide does not exceed the amount of ZnO and the ratio of FeO to CoO is between 4 to 1 and 16 to 1. CdO may be used in place of ZnO. (*C.A.*)

Furnace for bending sheets of glass. JACQUES ZINGG. Fr. 703,769, Oct. 16, 1930. (*C.A.*)

Annealing furnaces for glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY, ET CIREY. Fr. 703,986, Aug. 13, 1930. Temperature-regulating means is described. (*C.A.*)

Electric furnaces for melting glass. GENERAL ELECTRIC CO., LTD., ROLAND F. PROCTOR, AND HENRY C. BIGGS. Fr. 705,110, Nov. 4, 1930. (*C.A.*)

Fusing quartz, etc. I. G. FARBENIND. A.-G. Fr. 705,355, Nov. 12, 1930. Pure melts are made from substances of high melting point such as quartz, glass, etc., by a current of heating gas directed from the top down in a furnace provided with a mobile base. The substances are spread in a layer of uniform thickness, placed preferably on a support formed of the same materials as those treated. In the production of porous materials a hearth cooled by a circulation of water is used as the base of the furnace. (*C.A.*)

Apparatus for making sheets of glass. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Fr. 705,374, Nov. 12, 1930. (*C.A.*)

Furnaces for fusing glass. HARTFORD-EMPIRE CO. Fr. 705,513, Nov. 8, 1930; see also *Ceram. Abs.*, **10** [5], 346; [8], 566 (1931). (*C.A.*)

Rolls for producing sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 510,129, April 23, 1929. The introduction of cooling fluid into hollow rollers is carried out so that the tubes carrying it are not in direct contact with either the axles or the outer rollers themselves. (*J.S.G.T.*)

Annealing intermittently-produced glass sheets. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 510,506, June 4, 1927. The freshly-rolled sheet is fed forward toward the leer with a velocity higher than that with which it travels through it until it approaches the previously rolled sheet. The velocity is then reduced to that corresponding with the speed of the leer. (*J.S.G.T.*)

Changing glass sheet thickness while operating the rolls. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 513,879, Nov. 29, 1929. Means are provided for altering the separation of the rolls during their operation so that a sheet of different thicknesses is formed which, when cut at the lines corresponding with the change of thickness, gives sheets of varying thickness. The drive to the device controlling the separation of the rolls is operated by a trigger on the table tripping a switch and a second device actuating a switch. (*J.S.G.T.*)

Muffle furnace for melting glass. FRIEDRICH SÖLLNER. Ger. 525,516, Aug. 15, 1928. Details of construction and arrangement are given. (*C.A.*)

Apparatus for the continuous production of glass tubes. BORNKESSEL BRENNER UND GLASMASCHINEN G.M.B.H. Ger. 526,561, Feb. 26, 1924. (*C.A.*)

Working fused silica, etc. SOC. QUARTZ & SILICE. Ger. 527,047, April 11, 1930. A block of the material is heated above its melting point and then compressed between two pistons moving in a cylinder, with the result that the material is extruded into molds arranged around the cylinder and communicating therewith. (*C.A.*)

Filaments and fabrics made of glass transparent to ultra-violet rays. ILSE GERICKE. Ger. 527,404, Jan. 16, 1930. (*C.A.*)

Machine for making plate glass. INDUSTRIE- UND MONTAN G.M.B.H. Ger. 527,573, Aug. 24, 1929. (*C.A.*)

Glass of high transparency to ultra-violet light. DEUTSCHE SPIEGELGLAS A.-G. Ger. 528,394, July 9, 1929. A small quantity of SnO or $Sn(OH)_2$ is added to the frit. To facilitate the distribution, an alkaline solution of SnO may be used. (*C.A.*)

Trough furnace for melting glass. HANS HAUSNER. Ger. 529,734, Feb. 9, 1930. (*C.A.*)

Device for hardening glass plates. SOC. ANON DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 529,735, Feb. 1, 1930. (*C.A.*)

Tempering glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS

CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Ger. 530,154, Jan. 30, 1930; see also *Ceram. Abs.*, **10** [8], 564 (1931). (*C.A.*)

Material for preventing blur of glass. SIGEYASU IIZIMA AND TAROSAKU MIZUNO. Japan. 90,696, March 18, 1931. The material is a mixture of alkali silicate, glycerol, a borate, KI, an oleate, and gum arabic. (*C.A.*)

Structural Clay Products

Study of soil reaction in some experimental drainage plots at Cockle Park. B. THOMAS AND T. W. SIMPSON. *Chem. & Ind.*, **50** [37], 349–52 (1931).—Pipe drainage increases the mean p_H of soils to a depth of 30 in. Increasing the concentration of soluble salts tends to promote acid conditions. G.R.S.

Resurfacing with paving brick. ANON. *Brick Clay Rec.*, **79** [7], 289 (1931).—Methods followed in resurfacing 70 miles of Ill. hard roads are briefly described. Illustrated. E.J.V.

Brick road. F. WATTEBLED AND F. CARINI. *Rev. mat. constr. trav. pub.*, No. 262, pp. 135–37*B* (1931).—An interpretation is given of results obtained by the rattler test. See also *Ceram. Abs.*, **10** [11], 780 (1931). M.Y.H.

British brick for British roads. A. W. CROSS. *Trans. Ceram. Soc.* [Eng.], **30** [8], 278–87 (1931). C.G.H.

Value of a laboratory to a clayworks manager. E. SIMPSON. *Trans. Ceram. Soc.* [Eng.], **30** [8], 269–77 (1931).—A laboratory at a clayworks is useful for (1) feed-water control, (2) fuel testing, (3) lubricating oil testing, (4) raw-materials testing and control, (5) process and preparation control, (6) product testing, and (7) firing control. C.G.H.

Enlisting the architect's help in merchandising brick. SAMUEL PORTER. *Brick Clay Rec.*, **79** [6], 259 (1931).—A part of "Sky City," an unusual architectural and building display being developed by the Cleveland Chapter of the American Institute of Architects on the 17th and 18th floors of the Builders Exchange Building, consists of a number of interesting brick treatments as parts of actual buildings which illustrate the use of brick more satisfactorily than would an isolated display. Illustrated. E.J.V.

Brick display studio. JOHN A. MERCIER BRICK CO. *Brick Clay Rec.*, **79** [6], 263 (1931).—A Detroit, Mich., brick company has a display studio consisting of four rooms totaling 4200 sq. ft. of floor space. Illustrated. E.J.V.

Plant built of reënforced brickwork. ANON. *Brick Clay Rec.*, **79** [6], 262 (1931).—The Alwine Bros. Brick Co., New Oxford, Pa., has put up a plant building of reinforced brick using only their own regular employees in their spare time. Illustrated. E.J.V.

Brick baseball stadium. ANON. *Clay-Worker*, **96** [3], 150–51 (1931).—A detailed description of the Perry baseball stadium in Indianapolis is given. Illustrated. E.J.V.

American Red Cross building, New York. ANON. *Arch. & Bldg.*, **63** [5], 102 (1931).—This attractively colored red-brick building is described. E.P.R.

Steuben building, New York. ANON. *Arch. & Bldg.*, **63** [5], 106 (1931).—This building is of golden sand-struck brick rising from a buff limestone base with red and black spandrels. E.P.R.

Brickmaking in the Persian gulf. J. WILSON. *Brit. Clayworker*, **40** [473], 222–23 (1931).—Brickmaking in South Persia is carried on exactly as it was done thousands of years ago. The Anglo-Persian Oil Co. operates a plant having 36 kilns with a capacity of 55,000 brick per kiln. No machinery is used. The clay is dug by hand and the brick are hand molded at so much per thousand brick. A brief description is given of the kilns, which are of a peculiar design, and the firing of the brick. R.A.H.

BOOKS AND BULLETIN

Builders' Materials. R. F. B. GRUNDY. Longmans, Green & Co., London, 1930. *Mech. World*, **90** [2326], 110 (1931).—This book meets the needs of those who are engaged in the building trades or are preparing for examinations and who require information on ordinary builders' materials arranged in convenient form. A description is given of the uses and classification of timber, stone, brick, lime, cements, glass, roofing materials, etc. The book is illustrated and contains a useful index. E.P.R.

Brick Structures—How to Build Them. RALPH P. STODDARD AND L. B. LENT. Common Brick Mfrs. Assn., Cleveland, Ohio. Price 25¢. Reviewed in *Brick Clay Rec.*, **79** [7], 300 (1931).—This book contains practical reference data on materials, design, and construction methods employed in brick construction. It contains photographs and diagrams illustrating proper building practice with brick, technical information about the structural properties of brick, information on bonding, reinforced brickwork, and garden walls, and discusses every possible angle about brick masonry. E.J.V.

Tests on brick kilns fired with a stoker. W. E. RICE AND R. R. FALLER. Bur. Mines, *Rept. of Invest.*, No. 3122, 20 pp.; *Brick Clay Rec.*, **79** [6], 250–53 (1931).—For a description of tests made on stoker-fired kilns see Rice and Harrison, *Ceram. Abs.*, **10** [10], 700 (1931), E.J.V.

PATENTS

Fireproof floor construction. ROWLAND MCWILLIAMS. U. S. 1,825,237, Sept. 29, 1931. In a floor construction, a plurality of hollow blocks aligned in rows to define channels, adjacent blocks of each row being spaced apart to leave passages therebetween, reinforcing members in the channels above the level of the lower surfaces of the blocks, and concrete filling the channels and passages, the concrete terminating in planes substantially flush with the upper and lower surfaces of the blocks having substantially plane surfaces engaging the concrete and each of the blocks being formed of a dry mixture of cement, sand, and slag molded under heavy pressure and having such properties that concrete hardened against the surface thereof develops a bond strength of the order of the shear resistance of the concrete and the blocks.

Brick embossing machine. JOHN J. FRED BRAND. U. S. 1,825,938, Oct. 6, 1931. Apparatus for embossing a face of plastic brick ribbon while it is traveling beyond the extruding point of an extruding machine, comprising a rotatable carrier, a plurality of embossing rollers mounted in the carrier on axes parallel to the face to be embossed, and adapted to be brought into operative relation to the face by the rotation of the carrier, means for rotating the carrier in such direction as to translate the rollers adjacent the ribbon longitudinally of the ribbon, and means for rotating the rollers while in operative relation to the ribbon in the opposite direction to and at the same peripheral speed as the translatory movement of the parts of the rollers coacting with the ribbon.

Making brick. WILLIAM MCCLINTOCK. U. S. 1,825,969, Oct. 6, 1931. In a method of continuously producing brick having an irregular roughened surface, the steps of forming a substantially smooth clay column of stiff-mud characteristics, blasting a dry, hard, granular material into the surfaces of the clay column whereby the dry, hard, granular material is caused to be partially but firmly embedded in the surfaces, cutting the column thus treated to form a brick, and drying the brick thus formed.

Manufacturing sewer pipe, etc. HERMAN P. WILLIAMS. U. S. 1,826,586, Oct. 6, 1931. A method characterized by introducing loose material into a cylinder, subjecting the material in the receiving end portion of the cylinder to pressure that is applied to the material progressively from the center toward the side wall of the cylinder, thereby causing air that is mixed with the loose material to be expelled from it, and thereafter compressing the material to a high degree and forcing it into a shaping die.

Textured brick. EDWIN M. WYATT. U. S. 1,826,916, Oct. 13, 1931. As a new article of manufacture, a clay brick of standard dimensions adapted to present various exposures and comprising two broad oblong rectangular faces, two short and narrow end edges and two long and narrow side edges, and having one of its broad faces produced by severing and textured to improve the appearance of the surface, and having its two end edges and one of its side edges also textured.

Patterned brick wall. EDWIN M. WYATT. U. S. 1,826,917, Oct. 13, 1931. A brick wall consisting of superposed pattern courses, the contiguous pattern courses being separated by uninterrupted horizontal mortar lines, each pattern course including pattern units comprising a brick standing on edge as a bull stretcher and a brick laid flatwise, the superposed relation of the bull stretcher brick and the flat lying brick of each unit alternating in the pattern units in the same course to break joints between pattern units, and the pattern units in contiguous courses breaking joints to present the vertical joints between the pattern units in staggered relation in alternate courses.

Building brick or block. W. F. WALKER. Brit. 355,799, Sept. 9, 1931.

Brick. HENRIK NIELSEN. Fr. 704,271, Oct. 23, 1930. Brick are made by drying clay to a content of water below 10%, granulating the dried clay, molding by compression, and baking. (*C.A.*)

Apparatus for making porous brick, etc., with the application of reduced pressure. JULIUS SCHEIDEMANDEL AND SEBASTIAN KÖRBL. Ger. 528,102, Oct. 16, 1930. (*C.A.*)

Refractories

Thermal expansion of some refractory oxides. JAMES BLISS AUSTIN. *Jour. Amer. Ceram. Soc.*, **14** [11], 795–810 (1931).

Reversible thermal expansion of refractories. ANTON KANZ. *Mitt. Forsch.-Inst. Ver. Stahlwerke Akt.-Ges. Dortmund*, **2** [5], 77–96 (1931).—To measure reversible expansion, the method of Steinhoff was used (see *Ceram. Abs.*, **8** [9], 661 (1929)) on chamotte, SiO_2, quartz schist, magnesite, magnesia, bauxite, chromite, zirconia, and clay refractories. The average coefficient of each material varied considerably and depended upon temperature. In most cases it increased almost linearly with rising temperature, with the exception of those materials containing free SiO_2. Siliceous materials showed variations due to modification changes, although the specific gravity agreed with the thermal coefficient. With clay free from quartz, the grain size and the temperature have little effect upon the thermal expansion below the firing temperature. Expansion was very low. (*C.A.*)

Thermal properties of clays. O. KNAPP. *Glashütte*, **60**, 545 (1930).—The refractoriness of a clay is given approximately in Seger cones by the formula $29 + 0.23 (\%Al_2O_3 - 20)$, but the methods of T. Ludwig and of Shuen are admitted as more satisfactory because they make allowance for the fluxes present. (Actually the reverse is true of the figures cited.) The grain sizes of the fluxes and quartz also affect this property. The temperature corresponding with 40% deformation under 2 kg./sq. cm. is $1450° + 10 (\%Al_2O_3 - 15°)$ (probable error $\pm$ 25°). This temperature is influenced by the particle size of the clay, porosity, and any materials added. (*J.S.G.T.*)

Application of tensile tests to the study of the bonding of refractory materials. J. H. CHESTERS AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **30** [7], 258–67 (1931); see also *Ceram. Abs.*, **10** [3], 199 (1931). C.G.H.

Service spalling test for refractories. S. M. PHELPS, S. M. SWAIN, AND R. F. FERGUSON. *Refrac. Jour.*, **7** [9], 436 (1931); see also *Ceram. Abs.*, **10** [6], 432 (1931). E.P.R.

Slag and spalling tests on fire brick. J. F. HYSLOP AND H. C. BIGGS. *Trans. Ceram. Soc.* [Eng.], **30** [8], 288 (1931).—New slag and spalling tests are described. C.G.H.

Spinel structure. An example of variate atom equipoints. TOM F. W. BARTH AND E. POSNJAK. *Jour. Wash. Acad. Sci.*, **21**, 255–58 (1931).—Comparison of the observed and calculated intensities on the spinels, magnesium ferrite, and galliate, show that, instead of having Mg in (8*f*) and Al in (16*c*), 8 Al ions occupy positions in (8*f*) and 8 Al ions + 8 Mg ions are in (16*c*). It is pointed out that this behavior, in which the unit cell contains different atoms at structurally equivalent points (variate atom equipoint), probably is a general phenomenon. (*C.A.*)

Titanium dioxide in Dinas brick. D. S. BELIANKIN. *Jour. Inst. Metals*, **44**, 726 (1930); for abstract see *Ceram. Abs.*, **10** [8], 577 (1931). (*C.A.*)

Method for investigation of the degree of change of quartz in refractory products. W. A. SEGER AND E. CRAMER. *Chem. Zentr.*, **102** [7], 1044 (1931); for abstract see *Ceram. Abs.*, **10** [9], 644 (1931). J.G.T.

Quartz slate. ANON. *Refrac. Jour.*, **7** [8], 366 (1931).—"Quartz slate" is a crystalline, somewhat translucent siliceous rock, dull white in color, and probably of pre-Cambrian age. Its formation is "schistose" or roughly and rather indefinitely laminated. The blocks are sawed from the slab-like form in which they are quarried into brick shape. It is claimed to be nonspalling and will not crack, chip, or burst in use, no matter how violent the alternations of heat and cold. E.P.R.

Magnetization, a quick method of determination of iron in bauxites near the deposit. F. LEWINSON-LESSING. *Comp. rend. acad. sci.* [U.S.S.R.], pp. 301–302 (1928); *Chem. Zentr.*, **1**, 1660 (1930).—The content of Fe_2O_3 in bauxite suitable for Al production should not exceed 16.5%. The iron content can be determined by artificial magnetization of a pulverized sample. The readings of a magnetometer will show the approximate iron content. A special electromagnet or magnet with a magnetometer graduated by means of iron determinations is possible. J.G.T.

Refractories research. ANON. Dept. Sci. Ind. Research [London], *Annual Report*, 1929–30; *Pottery Gaz.*, **56** [646], 531 (1931).—The following problems were investigated during the year: (1) enamel kilns such as are commonly used for firing on-glaze decorations on pottery. In such firing the muffle-type kiln is used to protect the goods from combustion gases. The downdraft kiln may show greater fuel economy, but has a greater tendency to develop a reducing atmosphere which has a deleterious effect on the ware. (2) An apparatus has been developed which records quantitatively the penetration and corrosion of refractory materials by molten glass. This apparatus gives a record of the change in apparent weight of a refractory material when immersed in a molten glass or slag at a high temperature. The results will be of value in problems of corrosion of glass-tank blocks and walls and hearths of metallurgical furnaces. (3) A technique has been developed for measuring the plasticity of clays. (4) Research has been initiated on blast-furnace refractories and the mode of attack by the charge. W.L.

Advance in the refractory field in England in 1930. W. STEGER. *Feuerfest*, **7** [8], 113–20 (1931).—S. discusses the following subjects: (*A*) Refractory basic substances: (1) behavior of clay during drying in an atmosphere saturated with steam, (2) diluting water, shrinkage, and porosity of grog pastes, (3) fusing point of a feldspar-clay-sand mixture with additions of colloidal iron oxide in different gases, (4) Indian sillimanite and, (5) magnesite-zirconium oxide masses. (*B*) Clay-bonded refractory substances: (1) different kinds of grog in clay-bonded refractory blocks, (2) differences in structure in clay-bonded refractories in consequence of firing and, (3) measurements of load-bearing capacities of refractories with changes in the atmosphere. (*C*) Silica

blocks: (1) iron borate as a substance forming tridymite in silica blocks, (2) properties of silica blocks with repeated firing, and (3) changes in the linear thermal expansion during firing of silica blocks. (*D*) Hot patching of refractory walls. See also *Ceram. Abs.*, **10** [4], 276 (1931). M.V.K.

Refractory brick. J. SCHAEFER AND F. BAUMHAUER. *Refrac. Jour.*, **7** [9], 436 (1931); for abstract see *Ceram. Abs.*, **10** [8], 576 (1931). E.P.R.

Weathering plastic fire clays. S. M. PHELPS AND C. G. DENNEY. *Refrac. Jour.*, **7** [9], 436 (1931); see also *Ceram. Abs.*, **10** [5], 356 (1931). E.P.R.

Scorification of refractories. H. SALMANG AND O. HEBESTREIT. *Refrac. Jour.*, **7** [8], 400; [9], 436 (1931); for abstract see *Ceram. Abs.*, **10** [5], 353 (1931). E.P.R.

Special refractories. O. KUKLA. *Refrac. Jour.*, **7** [8], 400 (1931); see also *Ceram. Abs.*, **10** [2], 124 (1931). E.P.R.

Magnesite brick. F. REINHART. *Refrac. Jour.*, **7** [8], 400 (1931); see also *Ceram. Abs.*, **10** [7], 504 (1931). E.P.R.

High-alumina fire brick. J. F. HYSLOP. *Refrac. Jour.*, **7** [8], 400 (1931); for abstract see *Ceram. Abs.*, **10** [8], 577 (1931). E.P.R.

Sillimanite brick. F. SOMMER. *Refrac. Jour.*, **7** [8], 400 (1931); see also *Ceram. Abs.*, **10** [2], 124 (1931). E.P.R.

Slagging of refractories. H. SALMANG AND F. SCHICK. *Arch. Eisenhüttenwesen*, pp. 300–16 (1930); *Refrac. Jour.*, **7** [8], 400 (1931); see also *Ceram. Abs.*, **10** [10], 706 (1931). E.P.R.

Andalusite as a refractory. F. H. RIDDLE. (Report of the 59th Meeting of the Electrochemical Soc., Columbia Univ.) *Feuerfest*, **7** [7], 108 (1931).—R. discusses the practical development of sillimanite substance ($Al_2O_3 \cdot SiO_2$) and the favorable results obtained with natural andalusite mixed with a small amount of alumina as setting agent. The deposits of andalusite and results of tests with it are described. M.V.K.

Silica brick. M. L. LONGCHAMBON. *Corriere Ceram.*, **12** [8], 335–41 (1931); see also *Ceram. Abs.*, **10** [5], 380 (1931). M.V.K.

Alumina obtained from leucite (by G. A. Blanc's process). A. W. BONARETTI. *Chim. ind., agr. e biol.*, **6**, 252–59 (1931).—The process is described. (*C.A.*)

Refractories in carbonizing industries. T. F. E. RHEAD AND R. E. JEFFERSON. *Refrac. Jour.*, **7** [8], 400 (1931); for abstract see *Ceram. Abs.*, **10** [11], 783 (1931). E.P.R.

Control and researches on refractory materials in the gas industry. M. G. CHARLET. *Jour. usines gaz.*, **55** [10], 245–46 (1931); *Feuerfest*, **7** [7], 108 (1931).—The results and advantages of the methods used by the Soc. du Gas de Paris are given. The properties and manufacture of refractory materials used at present in the gas industry, current control of refractory substances already known, and the determination of the properties of new substances are also discussed. M.V.K.

Silica coke ovens. HUGHES. *Gas World*, **7**, 23–24 (1931); *Refrac. Jour.*, **7** [8], 400 (1931).—A study of modern coke ovens under abnormal conditions shows a difference of expansion between pure silica material and semisilica so great that it is not feasible to combine the two materials in the heated sections of ovens. Superimposed silica material exhibits considerable expansive force. E.P.R.

Refractory materials for the induction furnace. J. H. CHESTERS AND W. J. REES. *Iron & steel Inst.*, Advance Copy, May, 1931; *Feuerfest*, **7** [7], 105 (1931); *Refrac. Jour.*, **7** [8], 400; [9], 436 (1931); see also *Ceram. Abs.*, **10** [11], 783 (1931).

Choosing refractory linings for rotary kilns of cement plants. ANON. *Rev. mat. constr. trav. pub.*, No. 262, pp. 127–28*B* (1931).—Materials should be studied in regard to (1) vitrification of the fired material, (2) fusion, (3) silica ratio, and (4) analysis. Points 1 and 2 are explained in detail. M.Y.H.

Concerning pot attack by iron. M. A. BESBORODOV, M. F. SHUR, AND I. J. MOSHEIKO. *Keram. Rund.*, **39**, 198, 216 (1931).—The authors differentiate between pot attack by contamination and pot decomposition due to reaction between the pot material and the melted glass. Two kinds of pots were investigated and results of the following general type were obtained:

	Colorless glass from top layers of pot (1)	Dark-colored glass above the "contact layer" (2)	Porcelain "contact layer" of pot and glass (3)	*K* pot (4)
SiO_2	67.68%	69.14%	74.31%	77.01%
Al_2O_3	3.21	8.27	20.39	20.52
Fe_2O_3	0.30	0.43	3.37	1.08
B_2O_3	2.79	2.73		
TiO_2			0.35	Not estimated
CaO	8.97	5.91	0.60	0.60
MgO		Trace		
K_2O* }	17.05	13.52	0.98	0.79
Na_2O* }				

* By difference

They regard (2) and (3) as reaction products of (1) and (4) and, knowing the amphoteric nature of alumina, consider the reaction to be governed by the values of the two acid to alkali ratios given by

$$n_1 = \frac{SiO_2 + B_2O_3 + TiO_2}{K_2O + Na_2O + CaO + Fe_2O_3 + Al_2O_3} \quad \text{and}$$

$$n_2 = \frac{SiO_2 + B_2O_3 + TiO_2 + Al_2O_3}{K_2O + Na_2O + CaO + Fe_2O_3}.$$

For the glass above, n_1 and n_2 = 2.73 and 2.65, respectively, while the values for *K* pot are 5.60 and 55.0. Where the pot walls have suffered by erosion, a small pellet of melted iron (high in carbon) is often found, and when so found is always embedded in a white porcelain-like contact layer with a channel of brown-colored glass leading to the main body. In cases where n_1 for the pot is less than n_1 for the glass melted, pot attack is not so marked. See also *Ceram. Abs.*, **9** [9], 747 (1930). (*J.S.G.T.*)

Furnace-gas compositions and temperatures in underfeed stoker-fired boilers and their effect on boiler settings. A. E. PASINI AND E. M. SARRAF. *Engineering*, **130**, 794 (1931); *Refrac. Jour.*, **6** [65], 184 (1930).—Comprehensive experiments conducted show (1) the wide variations found in the furnace-gas compositions over the fire along the wall in underfeed stoker-fired installations, (2) the effects that varying thickness of fuel bed might produce on the brick in the setting, (3) the efficiency of the combustion, and (4) the temperature of the resultant superheated steam. The question of increasing the amount of excess air to reduce the severity of the temperature to which the refractory settings are exposed is also discussed. A.A.

Boiler-furnace walls. ANON. *Mech. World*, **90** [2331], 231–34 (1931).—The Bailey furnace wall and its use are described. E.P.R.

Larger coreless induction furnace; lining improved. E. F. NORTHRUP. *Steel*, **88**, [23], 39–42 (1931).—An effective and inexpensive method is described for using a pure zirconium silicate sand as a refractory lining for coreless induction furnaces. Florida zircon of the grade known as "Tam" to which has been added 15% of powdered zircon,

is packed with the aid of an air or electric hammer between the coil lining consisting of silicon carbide brick, and a conical steel mold surrounded by a layer of asbestos lumber. The top is sealed off with slightly dampened thermolith and the whole apparatus dried by heating the steel mold to dull redness. The first charge, made after the mold has been removed, melts out the asbestos and completes the lining by sintering the zircon. The lining is highly resistant to sudden temperature changes and does not affect the chemical composition of the melt. The requisites of an induction-furnace refractory, melting efficiency, alloy losses, and superheating of metals are discussed. See also *Ceram. Abs.*, **10** [10], 721 (1931). (*C.A.*)

Safeguarding quality of refractories. J. E. LEWIS. *Executive Service Bull. of the Metropolitan Life Insurance Co.; Amer. Glass Rev.*, **50** [51], 13–14 (1931).—The Harbison-Walker Refractories Co. has initiated many advances and is consistently availing itself of improvements in production methods. E.P.R.

Output of refractory stone in the U.S. ANON. *Refrac. Jour.*, **7** [9], 406 (1931).—The output of stone for refractory use, which includes domomite, quartzite, and mica schist, amounted to 1,348,160 short T., valued at $1,745,066 in 1928, a decrease in quantity of 1%. Raw dolomite sold in 1928 amounted to 522,850 short T., valued at $509-502. E.P.R.

Refractory clays of the Uzés. V. CHARRIN. *Céram. Verrerie*, No. 824, pp. 75–77 (1931).—C. discusses the fact that chemical analyses do not always determine the properties of a refractory clay. There is a short summary of the geology of the Uzés basin with a few chemical analyses of the clays. T.N.McV.

Manufacture of refractories at the Zlatoust Ceramic Works. W. N. SCHVETZOV. *Jour. Inst. Metals*, **44**, 723 (1930); for abstract see also *Ceram. Abs.*, **10** [8], 576 (1931). (*C.A.*)

High temperature refractories. W. H. SWANGER AND FRANK R. CALDWELL. *Refrac. Jour.*, **7** [8], 400 (1931); see also *Ceram. Abs.*, **10** [11], 784 (1931). E.P.R.

Fifty years of refractory organization. H. ANDRES. *Tonind.-Ztg.*, **55** [72], 1021–23; [73], 1036–37 (1931).—A. reviews the economical development of the German refractory industry during the past 50 years after the German Assn. of Mfrs. of Refractory Materials was founded. W.M.C.

Manufacture of chamotte brick in Germany. ANON. *Refrac. Jour.*, **7** [9], 407 (1931); see also *Ceram. Abs.*, **10** [6], 439 (1931). E.P.R.

BULLETINS

Bibliography on zinc retorts and condensers. B. M. O'HARRA. *Bull. Mo. School Mines & Met.*, **8** [4], 15 pp. (1925). E.C.C.

Changing of quartz into tridymite in silica block in the presence of mineralizers and a partial substitution of quartzites by sand in a silicate bed. P. P. BUDNIKOFF AND I. S. SMELJANSKY. *Research Inst. Silicate Ind.* [Charkov], **15**, 27 pp. (1930).—The authors have continued their research on 42 other samples of Dinas blocks (see *Ceram. Abs.*, **9** [7], 540 (1930)) and have obtained the following results: (1) Quartzites investigated can be used for preparing Dinas blocks only when fired to a high temperature (1460 to 1470°) and for a long time (24 to 48 hr.). (2) The grain size most suitable for their change into tridymite during firing was found to be a mixture composed of 10% grains from 5 to 2.5 mm. (3) The influence of different admixtures on the degree of conversion of quartz is as follows: (*a*) Martin slag promotes the process of converting quartz into tridymite (maximum 3%). (*b*) Phosphorites from Isium (from 2 to 3%) are good mineralizers' converting quartz into tridymite and giving a dense homogeneous body. (*c*) Soluble glass (about 1%) is a strong mineralizer but produces a less dense body. (*d* and *e*) Manganese oxide and coke powder promote the conversion of quartz

into tridymite. (*f*) Fired quartzites lower the specific gravity of Dinas blocks. (*g*) Fired Dinas (up to 15%) is desirable from every point of view. (*h*) Molasses (from 0.25 to 0.5%) promotes a greater durability of blocks. (*i*) Sand (up to 25%) promotes the conversion. (*j*) Clay up to 10% does not lower the quality of Dinas blocks. See also *Ceram. Abs.*, **10** [7], 505 (1931). M.V.K.

PATENTS

Furnace wall. DAVID S. JACOBUS. U. S. 1,823,901, Sept. 22, 1931. A furnace wall comprising tile having lugs extending beyond the ends thereof, supports for the tile, and straight pins passing through the lugs and supports.

Device for retaining furnace wall blocks against tubes. ERVIN G. BAILEY AND RALPH M. HARDGROVE. U. S. 1,823,927, Sept. 22, 1931. In a furnace wall, water tubes, tile having a portion between the tubes extending beyond the center line thereof, recesses in the sides of the extending portion, and bolts with lugs thereon between the recesses and tubes for keeping the tile in place, the bolts being rotatable to permit removal of the lugs from the recesses.

Repairing furnace roofs. JOHN P. MCLIMANS. U. S. 1,824,222, Sept. 22, 1931. The method which consists of building a roof structure in a holding means and lowering the structure in place, securing the structure, and removing the holding means.

Tube supported furnace wall. DAVID S. JACOBUS. U. S. 1,825,666, Oct. 6, 1931. In a furnace wall, a row of spaced water tubes, tile extending between the tubes and forming a wall having recesses opening toward the inner surface of the wall and receiving the tubes, and superheater tubes extending into the recesses between the water tubes and the inner surface.

Checkerwork. GEORGE E. STEUDEL. U. S. 1,826,227, Oct. 6, 1931. A checker-brick construction for use in blast-furnace stoves, etc., comprising, in combination, a course of standard brick disposed immediately above the arches in the stove, a course of standard brick arranged to occupy the upper part of the stove, and an intermediate course of specially formed brick interposed between the upper and lower courses of standard brick.

Preparation of alumina. WOLF JOHANNES MÜLLER AND HEINRICH HILLER. U. S. 1,826,895, Oct. 13, 1931. A process for preparing alumina from bauxite, which comprises heating bauxite with aluminate lye of approximately 20 to 22° Bé at temperatures above 190°C and corresponding pressures until the decomposition of the bauxite is substantially complete.

Abrasive and refractory. LÉON E. BOURDEAU. Fr. 37,864, Dec. 27, 1929. Addition to 547,234. A mixture for abrasives or refractories contains Al_2O_3 69, basalt 17, ilmenite 4.5, hydrated cerite 2, C 1.5, and Na fluosilicate 6 parts. (*C.A.*)

Terra Cotta

Modern engobing processes used in the roofing tile industry. ANON. *Tonind.-Ztg.*, **55** [73], 1032–33 (1931).—A new process is described for engobing roofing tile on the cutter table by means of two drums. Other processes of engobing the product which allow a large output are mentioned following a description of the drying process. W.M.C.

Substitution of andesite for acid-resisting ceramic ware. E. M. KHANIN. *Jour. Chem. Ind.* [Moscow], **6**, 1657–60 (1929).—A survey of demand and supply of ceramic ware for chemical industries of Russia is made and the application of andesite in the Caucasus for this purpose is considered. The properties of andesite from Arsha, Tsdo, and

Sakitzeti were studied. Their chemical compositions are approximately the same. Petrographic study showed that they are all pyroxene-containing andesite. Other values determined were specific gravity 2.27 to 31, resistance to acids 2.65 to 99, hardness 4.92 to 5.02, softening temperature 1100 to 1320°, liquefaction temperature about 1500°, and compressive tensile strength 811.5 to 888.8 kg./cm.^{2} These grades of andesite are suitable for use in acid-resisting ceramic ware. (*C.A.*)

Decay of stone in London buildings. A. C. FREEMAN. *Stone Trades Jour.*, **50**, 402–403 (1931).—After describing well-known instances of decay, F. states that building material should be treated with preservatives before it enters the damaging atmosphere, and that the quarry (or factory) is the proper place for treatment. H.H.S.

Durable, colorful, and artistic clay products. ANON. *Brick Clay Rec.*, **79** [6], 254–55 (1931).—Brief descriptions are given of some interesting and effective applications of colored terra cotta inserts, glazed face tile, and brick, some laid with special mortar joints. Illustrated. E.J.V.

Terra cotta plastics. K. SCHWERDTFEGER. *Tonind.-Ztg.*, **55** [57], 833–34 (1931).—Some modern terra cotta figures are shown. W.M.C.

Museum accessions. ANON. *Amer. Mag. Art*, **23** [1], 63 (1931).—A pottery plaque with a design by Viktor Schreckengost, recently acquired by the Cleveland Museum of Art, is illustrated. E.B.H.

PATENTS

Wall-bearing ceramic tile. PATRICK J. CONLEY. U. S. 1,825,779, Oct. 6, 1931. A wall-bearing brick provided on a side surface with a vertical dovetail groove forming a false mortar joint and dividing the surface into two substantially square areas each of which is surface finished to represent a tile, whereby a wall built of the brick will have a finished inner surface having the appearance of tile provided with continuous vertical and horizontal mortar joints.

Roofing tile. EDWIN A. MASTICK. U. S. 1,826,082, Oct. 6, 1931. A roofing tile having opposite edge portions, respectively, downwardly inclined and upwardly inclined, a trough-like portion forming a joint member secured to the upwardly-inclined edge, the latter forming one side of the trough-like portion, a concave portion connected to the downwardly-inclined edge, and intermediate concave and trough-like portions connected to each other and to the two first-mentioned portions, respectively, the first-mentioned trough-like portion and the portion second removed therefrom being formed with tile-attaching means, the two other and alternate concave portions being shallower than the tile-attaching portions.

White Wares

X-ray and microscopic studies of silicate melts containing ZrO_2. HELEN BLAIR BARLETT. *Jour. Amer. Ceram. Soc.*, **14** [11], 837–43 (1931).

X-ray diffraction examination of high-fired porcelain. E. J. MARTIN, D. W. FAULKNER, AND A. H. FESSLER. *Jour. Amer. Ceram. Soc.*, **14** [11], 844–50 (1931).

Manufacture of thin porcelain parts of close dimensional tolerances. L. I. SHAW, A. G. JOHNSON, AND W. J. SCOTT. *Jour. Amer. Ceram. Soc.*, **14** [11], 851–54 (1931).

Progress of fluidity in porcelain bodies. R. A. SNYDER. *Jour. Amer. Ceram. Soc.*, **14** [11], 855–65 (1931).

Cutlery marking of chinaware. R. F. GELLER AND A. S. CREAMER. *Jour. Franklin Inst.*, **211**, 517 (1931); see also *Ceram. Abs.*, **10** [10], 713 (1931).

(*Trans. Ceram. Soc.* [Eng.])

Crazing of English earthenware. II. A. HEATH. *Trans. Ceram. Soc.* [Eng.],

30 [6], 199 (1931); for abstract see *Ceram. Abs.*, **10** [1], 49 (1931); for Part I see *ibid.*, **3** [4], 103 (1924). C.G.H.

Physical properties of ceramic bodies made from soapstone and clay. M. BICHOWSKY AND I. GINGOLD. *Sprechsaal*, **64** [37], 679–82 (1931).—Twenty-seven ceramic bodies made up from soapstone with two clays and Zettlitz kaolin, respectively, in different quantities were tested in three series. The investigations comprise water absorption, impact strength, and expansion behavior. The results are given in tables and curves. The greatest stability on firing is found with the bodies containing kaolin, which also give the highest porosity values. The impact strength decreases with increasing clay content. The expansion coefficients between 20°C and 600°C show a minimum for each of the three series investigated which is found at different percentages of soapstone. The expansion coefficient decreases with rising firing temperature and longer time of firing. The cristobalite effect appears at about 200 to 220°C in the expansion curves. W.M.C.

Clay, stoneware, and mosaic tile. G. DAHL. *Tonind.-Ztg.*, **55** [70], 996–97 (1931).—A discussion on the definition of the three types of tile is presented. W.M.C.

Electrical porcelain manufacture. ANON. *Times Eng. Supp.*, **28**, 400 (1931).—Great progress has been made in North Staffordshire in the use of machinery for the manufacture of super-insulators, some of which are so large that they have to be railed into the kiln. H.H.S.

Influence of grinding time on the production of fines. LEONARD ANDREWS. *Trans. Ceram. Soc.* [Eng.], **30** [3], 98 (1931); *Ceram. Ind.*, **16** [2], 173–81 (1931); for abstract see *Ceram. Abs.*, **10** [2], 134 (1931). C.G.H.

Durability of bone-china hotel ware. A. S. W. ODELBERG. *Trans. Ceram. Soc.* [Eng.], **30** [6], 225 (1931); for abstract see *Ceram. Abs.*, **10** [8], 582 (1931). C.G.H.

Artificial teeth. ARTHUR VON GLASS. *Chem. Zentr.*, **102** [6], 893 (1931).—The most popular compositions of artificial teeth are (1) 81 parts feldspar, 14 parts quartz, and 5 parts clay, and (2) 73 parts feldspar, 24.6 parts quartz, and 2.3 parts marble. Feldspar should not be too fine grained. The mass of the tooth is made up of 2 to 3 layers differently colored, pressed in bronze dies, dried at 200 to 300°, finished at 1320 to 1350° in a SiC furnace, and subjected to tests for hardness, transparency, and structure. J.G.T.

Batting machine for jolleying and jiggering: study of plastic clays under pressure. J. W. MELLOR. *Trans. Ceram. Soc.* [Eng.], **30** [7], 235–43 (1931).—The original problems were (1) to find a relation between the tool pressure on a plastic clay being molded in a machine, the angle of the tool, and the rate of flow of the clay, and (2) to find a relation between the pressure of the tool and the proportion of water the clay can carry without flaking or tearing. The tentative solution of these problems is summarized in formulas. Conclusions drawn are fundamental to any type of machine shaping or molding plastic clay. C.G.H.

Slight upward trend in British pottery industry. ANON. *Ceram. Ind.*, **17** [4], 335–37 (1931).—News and events of the ceramic industry in England are given. Many plants have installed electric kilns. W.W.M.

PATENT

Insulator. GEORGE M. BARROW. U. S. 1,824,766, Sept. 29, 1931. An insulator comprising an insulating member having a pin recess and a longitudinally-divided insulating sleeve secured in position in the recess for holding coöperation with a pin removably associated with the insulator in the recess.

Equipment and Apparatus

Air conditioning in theory and practice. R. C. PARMELEE. *Can. Chem. Met.*, **15** [9], 235–38 (1931).—Illustrated. E.J.V.

Science and practice of drying. VI. ANON. *Brit. Clayworker*, **40** [473], 202–205 (1931).—A discussion of the ventilating and induced-draft types of fans as applied to drier installations. Instruments for studying and controlling humidity, speed and volume of air, and draft pressures are also discussed. For Parts III, IV, and V see *Ceram. Abs.*, **10** [11], 792 (1931). R.A.H.

Constant control during drying. K. O. SCHULZ. *Tonind.-Ztg.*, **55** [70], 993–94 (1931).—To control drying conditions in an artificial drying plant for brick, an apparatus is used which is built similarly to a balance for letters. A brick is suspended from it while in the drying chamber and the progress of drying may be registered on a rotating drum. W.M.C.

Faulty constructions of air-drying plants. V. PINKL. *Tonind.-Ztg.*, **55** [40], 589–90 (1931).—Sketches are given of brick plants in which the drying sheds are arranged in such a way that drying can take place in an efficient and an inefficient way, respectively. The main reasons for not obtaining satisfactory results in drying at different places are that (1) rain water cannot flow away quickly enough and (2) the sheds are too broad and are not arranged according to a preliminary plan, thus causing long transports. W.M.C.

Faulty constructions of air-drying plants. ANON. *Tonind.-Ztg.*, **55** [57], 830–31 (1931).—This is a discussion of the preceding abstract. W.M.C.

Considerations of the thermal efficiency of plant drying of brick. R. CZERNY. *Ziegelwelt*, **62**, 45–47, 122–23 (1931). (*C.A.*)

New fuel and air ratio meter. BAILEY METER CO. *Instruments*, **4** [9], 516 (1931). J.G.T.

Automatic air coloring device for decorating. PAASCHE AIRBRUSH CO. *Amer. Glass Rev.*, **50** [50], 32 (1931); *Brick Clay Rec.*, **79** [3], 136 (1931); for abstract see *Ceram. Abs.*, **10** [11], 787 (1931).

Study of apparatus for cutting brick, etc. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 262, pp. 131–34*B* (1931).—Pug mills possessing cylinders for feed, grinders, and puggers are described. See also *Ceram. Abs.*, **10** [11], 794 (1931). M.Y.H.

Reducing vibration. KELDUR CORP. *Abrasive Ind.*, **12** [10], 30 (1931).—The Keldur Corp., Newark, N. J., has developed a vibration-absorbing material of rubber-like composition for use under grinding machines. It is resilient rather than elastic. E.P.R.

Apparatus for measuring permeability of construction materials. R. GUILLERY. *Rev. mat. constr. trav. pub.*, No. 262, pp. 277–80 (1931).—The apparatus is described and drawings are included. M.Y.H.

Deterioration during use of a filter for ceramic pastes. CAMILLO LEVI. *Boll. staz. sper. ind. carta e studio fibre tessili vegetali*, **10**, 50 (1931).—Corrosion is observed only in the center of the filter coming in contact with the ceramic paste. The chemical and microscopic examination of the cloth in the altered and yellow part confirms rotting by bacterial infection, favored by the mechanical wear. In the corroded zone the cotton fiber has secretion residues but no extraneous matter for favoring infection. Colloidal substances of humic nature are present, such as accompany cellulose fermentation; oxy- and hydro-cellulose, nitrates, and phosphates are absent. (*C.A.*)

Passage of gas through the walls of pyrometer-protection tubes at high temperatures. WM. F. ROESER. Bur. Stand., *Jour. Research*, **7** [3], 485–94 (1931); R.P. No. 354.—After a brief discussion of the contamination resulting from the use of tubes which are not gas-tight, the results of the measurements of the rate of passage of air through

36 tubes of refractory porcelain (11 different classes), 2 of fused silica, 1 of Pyrex glass, 2 of Alundum, and 15 of metal are given for various temperatures which the tubes would withstand without noticeable deformation. Methods of testing are described and a brief discussion is given of the processes by which air may pass through the tube walls. The results also indicate the degree of vacuum obtainable in porcelain tubes at 1400°C. The tests indicate that refractory porcelain tubes (often referred to as sillimanite or mullite) are decidedly superior to the older porcelain tubes both in refractoriness and gas-tightness. R.A.H.

Temperature control in manufacture of ceramic products. W. O. HEBLER. *Instrument World*, **4**, 41 (1931); for abstract see *Ceram. Abs.*, **10** [10], 722 (1931). H.H.S.

New temperature regulator. SARCO CO., INC. *Gas Age-Rec.*, **68** [12], 433 (1931).—Illustrated. E.J.V.

Adiabatic calorimeter. BURGESS-PARR CO. *Gas Age-Rec.*, **68** [11], 398 (1931).—Illustrated. E.J.V.

Automatic scale for weighing cement in bulk. ANON. *Eng. News-Rec.*, **107** [3], 117 (1931).—An automatic scale for batching loose or bulk cement from a storage bin within a tolerance of $^1/_2$ of 1% is described. W.L.

Dust removal from industrial gases by the Cottrell process of electrical precipitation. C. W. HEDBERG. *Mech. World*, **90** [2332], 243–45 (1931); for abstract see *Ceram. Abs.*, **10** [11], 799 (1931). E.P.R.

Dust arrester. ANON. *Rock Prod.*, **34** [19], 103 (1931).—A new and novel arrangement and application of dust-collecting principles are embodied in the dust filter announced by W. W. Sly Mfg. Co., Cleveland, Ohio. The apparatus is described and illustrated. W.W.M.

Conveyers for the porcelain industry. E. HERFELDT. *Sprechsaal*, **64** [38], 699–701; [39], 715–16 (1931).—Different types of conveyers installed in porcelain and other plants and the importance of their use for efficient handling of products are discussed. Illustrated. W.M.C.

Keeping the conveyer belt straight. ROBINS CONVEYING BELT CO. *Brick Clay Rec.*, **79** [6], 270 (1931); *Gas Age-Rec.*, **68** [13], 467 (1931); *Ceram. Ind.*, **17** [4], 324 (1931).—The belt-trainer designed to protect the edges of conveyer belts by keeping the return run exactly on the conveyer center line, is a tubular roller mounted on a single antifriction bearing at its center. The bearing is internally pivoted upon a fixed swivel pin located on the center line of the conveyer and inclined forward about 30°. Illustrated. E.J.V.

Power consumption of mills. ANON. *Emaillewaren-Ind.*, **8** [31], 241–42 (1931).—Data on the power consumption of different mills for grinding enamels used in Germany are given. M.V.K.

Handling costs problem tackled. FLOYD C. HORN. *Brick Clay Rec.*, **79** [6], 258–59 (1931).—At the McNear Brick Co., San Francisco, a machine for handling brick in units of 992 or 1984, depending on the size of the machine, is used for loading, carrying, and stacking brick. The principle involved is the application of even pressure on the ends of a tier of brick, binding individual units against each other and creating what amounts to a solid mass. A detailed description of the operation and construction of the machine is given. Illustrated. E.J.V.

Use of excavators in the ceramic industry. L. ORTHLIEB. *Rev. mat. constr. trav. pub.*, No. 262, pp. 128–31*B* (1931).—The constituent parts and the three movements of excavators are explained. A description is given of the two methods of working, *i.e.*, (1) on a knoll and (2) in a hollow. The excavator manufactured by Landuydt of Belgium is described. M.Y.H.

Different types of excavators. W. HAENDLE. *Tonind.-Ztg.*, **55** [74], 1041–42; [75], 1056–57 (1931).—A short review is given of the different types of excavators which may be used for handling the raw materials of ceramic plants. Illustrated. W.M.C.

Testing machine for insulators. ANON. *Engineering*, **132** [3420], 131–32 (1931).—A machine manufactured by W. and T. Avery, Ltd., and suitable for testing insulators of either the post or string type is described and illustrated. It can be used for tension or torsion tests or for a combination of the two, and also for a combined tension and vibratory test up to a maximum load of 24,000 lb. A.A.

Washing the sand for sand-lime brick. B. KRIEGER. *Tonind.-Ztg.*, **55** [70], 997 (1931).—A new machine is described for washing sand in sand-lime brick plants, which is especially recommended for colored brick. W.M.C.

Alloys for use at high temperatures. III. Complex iron, nickel, and chromium alloys. C. H. M. JENKINS AND H. J. TAPSELL. *Engineering*, **131** [3411], 713–14 (1931); for Parts I and II see *Ceram. Abs.*, **9** [10], 860 (1930). A.A.

BULLETINS AND BOOK

Descriptive bibliography on oil and fluid flow and heat transfer in pipes. JOE B. BUTLER. *Bull. Mo. School Mines & Met.*, **9** [4], 62 (1926). E.C.C.

Handbook of Mining Machinery. (Lehrbuch der Bergwerks Maschinen (Kraft- und Arbeitsmaschinen).) H. HOFFMANN AND C. HOFFMANN. Julius Springer, Berlin. 2d ed. 547 illustrations. Price 24 M. Reviewed in *Engineering*, **132** [3422], 206 (1931). A.A.

Electrical precipitation as applied to gas streams. H. R. HANLEY. *Bull. Mo. School Mines & Met.*, **9** [2], 64 (1926).—The removal of smoke, dust, and fumes from industrial exhaust gases is studied. E.C.C.

Orifice measurement of air in large quantities. ELMO G. HARRIS. *Bull. Mo. School Mines & Met.*, **2** [2], 18 (1915). E.C.C.

Friction in air pipes. I. E. G. HARRIS. *Bull. Mo. School Mines & Met.*, **1** [1], 16 (1911). **II.** *Ibid.*, **1** [4], 10 (1912). E.C.C.

Driers. C. O. BARTLETT & SNOW CO. *Pit & Quarry*, **22** [13], 76 (1931).—This company has issued a bulletin describing and illustrating its complete line of drying machinery and explaining the drying principle employed. Tables in the back of the book show the weight and volume of dry air at different temperatures, properties of saturated steam and air, and the specific heats of various materials. E.P.R.

PATENTS

Induction furnace. PORTER H. BRACE. U. S. 1,823,873 and 1,823,874, Sept. 22, 1931. (1) An induction furnace including a crucible, an induction coil therearound, and a grounded, water-cooled, protecting shield between the crucible and the induction coil. (2) In an electric induction furnace, in combination with an annular crucible, an energizing coil surrounding the crucible, a magnetic core operatively associated with the crucible and the coil, a current-conducting annular member located in the crucible, and means for closing and opening an electric circuit therethrough.

Induction furnace. THOMAS H. LONG. U. S. 1,823,908, Sept. 22, 1931. In an electric inductive heating device, a plural-turn energizing coil embodying a radially-laminated conductor and a fluid-cooled thermal shield located between the energizing coil and material to be inductively heated thereby.

Induction furnace. NEVILLE RYLAND DAVIS. U. S. 1,823,970, Sept. 22, 1931. In an electric induction furnace having a crucible, an induction coil surrounding the crucible, and a casing therearound, an earthed electric-conducting screen located within the casing and between it and the crucible.

Making curved bodies. GEORG HARTMANN. U. S. 1,824,482, Sept. 22, 1931. A molding machine comprising a curved die terminating in an overhanging lip, means for rotating the die, an auger machine for supplying material to the die whereby a helical body is formed by material discharged from the die during its rotation, and means for receiving and conveying the helical body, the operation of the conveying means being controlled in accordance with the pitch of the helical body.

Brick-molding machine. ABIRAM A. OEFFNER AND VINCENT TROTTA. U. S. 1,824,493, Sept. 22, 1931. In a machine, a mold, a carriage for moving the mold from charge-receiving position to mold-inverting position while maintaining the mold upright, means for covering the mold with a pallet while the mold is on the carriage, and operatively associated means for inverting the covered mold while retaining the pallet thereon.

Making vitrified argillaceous products. WILLIAM B. PINE. U. S. 1,824,684, Sept. 22, 1931. A process for treating argillaceous materials which comprises heating a mass of the materials to a temperature at which it becomes somewhat plastic but not completely fused, distributing the hot mass into separate portions, separately densifying the portions by applying compacting pressure thereto while so heated, and welding the hot portions together.

Producing decorative effects by spotting or mottling. ROBERT FRANKLIN GRADY, JR. U. S. 1,825,227, Sept. 29, 1931. Apparatus comprising a valveless air motor having two exhausts, means for conveying air under pressure to the motor whereby pulsations of air are forced from the exhausts in alternation, two nozzles, a connection between each exhaust and one of the nozzles, two sources of liquid color, and means for conveying one color to each nozzle whereby spurts of color are intermittently and in alternation ejected from the nozzles.

Clay gun. WILLIAM JOHNSTON, JR. U. S. 1,825,734, Oct. 6, 1931. A clay gun operating mechanism having in combination a gun-supporting carriage, a pedestal post, a sleeve rotatably mounted on the pedestal post, a pivotal support for the carriage on the sleeve, and an adjustable connection between the carriage and the sleeve for adjusting the carriage about the pivotal support.

Collecting and conveying materials. GEORGE R. SYLVESTER. U. S. 1,826,840, Oct. 13, 1931. Apparatus for collecting material comprising traction means, a body portion mounted on the traction means, plates extending along opposing sides of the body portion, endless conveying members with their lower side portions mounted to travel along the plates and with their upper sides spaced therefrom, and spur members projecting outwardly from the sides of the conveying members for cutting into the material to be collected.

Machine for finishing edges of strips, sheets, and plates of marble, glass, etc. K. A. WEBER. Brit. 356,099, Sept. 16, 1931.

Installation for obtaining high temperatures in a rotary furnace for fusion of minerals, etc. H. GARREAU. Brit. 356,184, Sept. 16, 1931.

Viscosity-indicating instruments. L. A. MAPEL. Brit. 356,721, Sept. 23, 1931.

Apparatus for vibrating screens, shaking tables, etc. GENERAL ELECTRIC CO., LTD., AND J. W. SHERWEN. Brit. 357,214, Sept. 30, 1931.

Drying chamber for brick. OTTO GRÜBER. Ger. 528,720, June 17, 1930. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Firing porcelain in tunnel kilns. HENTSCHEL. *Refrac. Jour.*, **7** [9], 436 (1931); for abstract see *Ceram. Abs.*, **10** [10], 721 (1931). E.P.R.

Control of kilns in ceramics. KARL MÜNZER. *Rev. mat. constr. trav. pub.*, No. 261, pp. 107–109*B* (1931); for abstract see *Ceram. Abs.*, **9** [6], 451 (1930). M.Y.H.

Insulation of continuous kilns. COLIN PRESSWOOD. *Refrac. Jour.*, **7** [9], 411–15 (1931).—Insulation is an investment. Wall thickness reduction by insulation saves labor and materials, thus offsetting the cost of insulation. The thicker the insulating layer, the less will be the temperature drop through the firebrick wall. The advantages of insulating the Hoffman kiln and tunnel car kilns are described. See also *Ceram. Abs.*, **9** [11], 960 (1930). E.P.R.

Economy of insulating kilns. H. L. CAMPBELL. *Brick Clay Rec.*, **79** [5], 224–26 (1934).—The Hazleton (Pa.) Brick Co. has increased the average production from 30,000 brick per day in 1919 to 75,000 brick in 1931 without increasing the six original kilns. The arches of the kilns were insulated with three $^1/_2$-in. coats of cement and with two $1^1/_2$-in. layers of Superex insulating brick, the whole covered with a $2^1/_4$-in. course of red brick under a sheet of heavy roofing felt made waterproof with a $^1/_2$-in. layer of Insulkote. A reduction of 13.3% in the fuel consumption was obtained and a net annual saving of $4960 was made. This saving paid for the entire investment in insulation in the first year. Illustrated. E.J.V.

Calculating losses through walls of industrial kilns. E. MAASE. *Feuerfest*, **7** [7], 97–102 (1931).—M. discusses the significance and reason for loss of heat through walls and by conduction, and gives the mathematical and graphic determination of these losses. The relation between the coefficient of thermal conductivity and physical conditions is explained. Losses through walls due to gas permeability, with the mathematical and graphic determination of this phenomenon, are treated. M.V.K.

Impending problem in the common brick industry. W. D. RICHARDSON. *Clay-Worker*, **93** [6], 160 (1931).—The problem for the common brick manufacturer is the adoption of an economic kiln that will produce 100% face brick. The advantages of the car tunnel kiln in this connection are enumerated and discussed. E.J.V.

System for reducing consumption of fuel in brick kilns. VANELLI FERMO. *Corriere Ceram.*, **12** [8], 347–51 (1931).—By the use of a forced draft in brick kilns, maximum heat is obtained from the fuel, consumption of fuel is lowered, firing is more rapid, and the charge can be packed more closely in the kiln. M.V.K.

Conservation of coal. C. LANGE. *Rev. mat. constr. trav. pub.*, No. 261, pp. 113–15*B* (1931); see also *Ceram. Abs.*, **10** [10], 723 (1931). M.Y.H.

Standard specifications for solid burning materials. ZAEPKE. *Arch. Wärmewirt.*, **12** [6], 184–85 (1931).—A review is given of the standard specifications adopted or proposed by the German Assn. for Testing of Technical Materials. The specifications cover sampling, treating samples of solid burning materials and pulverized coal, calorific value, etc. The specifications on a general survey of solid burning materials, chemical tests and determination of coke, and volatile substances of solid burning materials are under consideration. W.M.C.

Table for calculation of heat values of solid fuels. W. ZWIEG. *Chem.-Ztg.*, **55** [75], 723 (1931).—Using the Berthelot-Mahler-Kröcker bomb with the Beckman thermometer, the values for exactly 1 g. of a number of solid fuels were determined. These values are arranged in tables and have been used by Z. for several years with great economy of time. J.G.T.

Theory and practice of the gasification of coal in producers. H. L. PIRIE. *Mech. World*, **90** [2330], 193–95; [2331], 217–19 (1931).—Tables of chemical reactions and characteristics of gases are given and emphasized. Diagrammatic sections of a producer are given divided into four zones: (1) ash, (2) combustion, gasification, or oxidation, (3) reduction and decomposition, and (4) distillation. The theoretical efficiency of the producer and the deleterious effect of CO_2 are explained. E.P.R.

Gasoline from coal. ANON. *Mfrs. Rec.*, **99** [20], 43 (1931). E.P.R.

Oil from coal. CHAIRMAN OF IMPERIAL CHEMICAL INDUSTRIES, LTD. *Mech.*

World, **90** [2329], 173 (1931).—Hydrogenation has already reached the stage at which a plant at Billingham is capable of hydrogenating 15 T. or more per day of bituminous coal. Of the clean dry coal so treated, 60% by weight is recovered as refined petrol which has been utilized with complete success for many months past in motor vehicles of all descriptions. E.P.R.

Modern combustion, coal economics, and fuel fallacies. CLARENCE V. BACK. *Arch. Forum* [Part 1], **55** [3], 16 (1931).—Modern combustion is treated in five sections. E.P.R.

Coal and combustion equipment research. F. H. FISH AND W. T. ELLIS. *Mfrs. Rec.*, **100** [3], 22–23 (1931).—The Virginia Coal Operators' Assn. at a meeting in May, 1931, voted to support a graduate fellowship in fuel engineering at the Virginia Polytechnic Institute. A series of tests of different Va. coals is now being run in the plant to determine their suitability for use in state institutions. Much information about the coals of Va. is being collected at the chemical laboratory of the Engineering Expt. Station, in coöperation with the Chemical Engineering Dept., and a study of "Distribution of Ash in the Merrimac Coal Seam" is a feature. Determination of quality of the gases given off from Va. coals is being undertaken this summer. The coal is to be heated at 500, 600, 700, and 800°C and the gases given off at each temperature are to be analyzed. The tests are being made to determine why Va. coals are so much less smoky than other coals of the same relative amounts of volatile combustible matter. E.P.R.

Coal pulverizer for small plants. FULLER-LEHIGH CO. *Mfrs. Rec.*, **100** [3], 38 (1931). E.P.R.

First report on oil firing. S. R. HIND. *Trans. Ceram. Soc.* [Eng.], **29** [7], 149–68 (1930).—H. shows tables comparing oil and coal consumption and time of firing. Fuel oil costs more than coal, but savings of labor, higher efficiency, and reduced time of firing are substantial. The quality of ware is as good if not better than that in coal-fired kilns. Glost ware always has a higher gloss than that fired more slowly in coal kilns. Figures are given comparing the economy of oil and coal firing. The cost of oil-firing equipment is discussed. The appendix gives a short discussion of the nature of fuel oil and its more important properties, together with a method of evaluating these properties. In Appendix II are notes on oil burners with particular reference to steam jet burners. Appendix III contains data on the combustion and heat losses due to products of combustion and excess air. C.G.H.

Application of oil burning to the ceramic industry. G. JUNCK. *Chem. Eng. Mining Rev.*, **23** [275], 414–18 (1931).—The conversion of periodic downdraft kilns to oil fuel is described and it is suggested that new kilns lined with silicon carbide should be designed for oil burning. H.H.S.

Factors to consider in buying fuel oil. IV. ANON. *Brick Clay Rec.*, **79** [7], 310 (1931).—Pour point is the lowest temperature at which fuel oil will flow but it in no way indicates the combustion quality of the fuel. Both viscosity and pour point are affected by temperature. For Part III see *Ceram. Abs.*, **10** [11], 800 (1931). E.J.V.

Natural gas firing fireclay products. JOHN H. BAXTER. *Brick Clay Rec.*, **79** [7], 304–10 (1931).—The overhead system of piping having a regulating cock with a graduated dial for controlling the flow of gas is recommended. The design of gas burner depends primarily upon the use to which the heat of the fuel is to be put and also upon the B.t.u. content of the gas. Various types are discussed. A firing schedule for gas-fired kilns is discussed. Flashing the kiln to give the desired color to the finished product is taken up. Illustrated. E.J.V.

Waste-heat recovery from gasworks retorts. ANON. *Engineering*, **132** [3419], 104–105 (1931). A.A.

Natural gas in southern industry. J. B. NEALEY. *Mfrs. Rec.*, **99** [20], 31–33 (1931).—Some southern industries employing natural gas for heat and power generation are outlined to show the diversity of application of this comparatively new fuel resource. E.P.R.

New firebrick plant utilizes natural gas for fuel. K. B. ANDERSON. *Gas Age-Rec.*, **68** [14], 469–70 (1931).—A description is given of the Pittsburgh plant of the Stockton Fire Brick Co., where the firing is done in a 406-ft. Harrop tunnel kiln using natural gas as the fuel. Operating technique and condition control used in the plant are discussed. Illustrated. E.J.V.

Suggestions for the prevention of coal-dust explosions. W. P. RICE. *Pit & Quarry*, **22** [12], 62 (1931). E.P.R.

Color measurements for determination of ash content of coals. W. GROSS AND C. ABRAMSKY. *Glückauf*, pp. 1579–82 (1930); *Gas Age-Rec.*, **68** [14], 492 (1931).—The degree photometer and its operation for use in determining the ash in coals are described. Measurements are based upon the white or black color content of samples as shown by the Grey Scale of Ostwald, the assumption being made that the white content is a function of the ash content. With the aid of prepared curves, in which white content is plotted against actual ash content for coals from particular seams, the ash of a sample can be determined quickly by first determining the white content. E.J.V.

Future of smoke abatement. H. P. MILLER. *Chem. Met. Eng.*, **38** [9], 511–12 (1931).—A discussion is given of the present methods of smoke abatement and future developments are outlined. G.R.S.

BOOKS AND BULLETIN

Chemistry of Coals. (Die Chemie der Kohle.) W. FUCHS. J. Springer, Berlin. 510 pp. Price 45 Rm. Reviewed in *Mining & Met.*, **12** [298], 12 (1931).—F. summarizes present-day views on the chemistry of coal, lignite, and peat, covering the literature to March, 1931. Chapter I treats of the chemical composition and decomposition of the coal-forming plants. Chapters II to IV treat of peat, lignite, and coal, discussing their petrographic, physical, and chemical characteristics, their reaction to chemical and biological agents, behavior when heated, origins, etc. The final chapter gives methods of analysis and discusses their results. E.J.V.

Gas Installations and Appliances. A. T. GILBERT. Price 8s 6d net. Reviewed in *Engineering*, **132** [3420], 129 (1931); for abstract see *Ceram. Abs.*, **10** [9], 658 (1931). A.A.

Technical Fuel Practice. M. DOLCH. Reviewed in *Mining & Met.*, **12** [298], 12 (1931); for abstract see *Ceram. Abs.*, **10** [10], 724 (1931). E.J.V.

Effect of certain operating variables on the efficiency of the coal-washing table. H. F. YANCEY AND C. G. BLACK. Bur. Mines, *Rept. of Invest.*, No. 3111, 13 pp. The report gives results of tests to establish the relationship which energy input, distribution, and rate of feed or tonnage treated bear to the efficiency of the separation of a coal-washing table. It contains data on the amount of water required in tabling coal. R.A.H.

PATENTS

Material container for dental furnaces. ORA A. COLBY. U. S. 1,823,968, Sept. 22, 1931. In a dental furnace, means for supporting and protecting an artificial tooth during the heating and cooling thereof including a supporting tray and a cover therefor of highly refractory material, means coöperating with the cover to constitute a substantially dustproof enclosure for the tooth, integral handling means on the cover, and a depression at the junction of the handling means and the cover to receive a temperature-indicating means.

Gas generator. CHARLES S. CHRISMAN. U. S. 1,824,764, Sept. 29, 1931. In a gas generator, a rotatable bosh member of frusto-conical shape having a central opening therein, cutter bars mounted thereon on the inner frusto-conical surface, ploughs mounted on the outer frusto-conical surface on the opposite side of the rotatable member from the cutter bars, and a central body located in the central opening but spaced from the rotatable member.

Kiln car construction. GEORGE D. MORRIS. U. S. 1,824,917, Sept. 29, 1931. A tunnel kiln car having a superstructure comprising a plurality of refractory slabs having adjacent edge surfaces forming longitudinally and transversely extending joints, a plurality of supporting girders extending transversely of the car and positioned over the transversely extending slab joints, and cover plates mounted on the slabs between the transverse girders and extending over the longitudinally extending slab joints.

Kiln for decorating ceramic ware, etc. HARRY M. ROBERTSON. U. S. 1,827,543, Oct. 13, 1931. The combination of a heating and firing section and a cooling section, a transverse separating wall structure between the inner ends of the sections and having insulation means, the wall structure having a longitudinal opening through it, a muffle in each section in line with the opening and connected thereto to form a continuous muffled passage for loaded conveyers, means for supporting each muffle in spaced relation to the walls of the adjacent section, and means for supplying heat to the inner end portion of the heating section.

Superstructures of tunnel-kiln trucks. GIBBONS BROS., LTD., AND W. E. GIBBONS. Brit. 356,615, Sept. 16, 1931.

Continuous-charge furnace for ceramic kilns, etc. ANTONIN FÜRST. Austrian 123,046, Jan. 15, 1931. (*C.A.*)

Continuously operating channel kiln for ceramic goods, etc. JOSEF HEMMER. Austrian 123,519, Feb. 15, 1931. (*C.A.*)

Ceramic furnaces. ROBERT LEDUC. Fr. 705,353, Nov. 12, 1930. Means for feeding the fuel is described. (*C.A.*)

Tunnel kiln for brick firing. HOLDING-GES. FÜR KERAMISCHE WERTE. Ger. 528,956, Oct. 9, 1930. (*C.A.*)

Tunnel kiln. HOLDING-GES. FÜR KERAMISCHE WERTE. Ger. 529,707, Feb. 25, 1930. Details of operation are presented. (*C.A.*)

Tunnel kiln for ceramic goods shaped by pressure. PORZELLANFABRIK KAHLA, ZWEIGNIEDERLASSUNG FREIBERG. Ger. 530,269, Sept. 29, 1929. The kiln includes a separate preheating chamber in which the goods are indirectly heated, the press-oil vapors evolved from the goods being recovered. (*C.A.*)

Geology

Kaolin minerals essential in porcelain and chinaware. ANON. *Nat. Glass Budget*, **47** [19], 16 (1931).—The results of a detailed study of these minerals have just been published by the U. S. Geological Survey. See following abstract. E.P.R.

Geological Survey study of kaolin minerals. ANON. *Pit & Quarry*, **22** [13], 36 (1931).—The results of a detailed study of kaolin minerals have just been published by the U. S. Geological Survey, Dept. of the Interior, in Professional Paper 165-E. E.P.R.

Kaolinite minerals. C. S. ROSS AND P. F. KERR. *Chem. News*, **143** [3724], 143–44 (1931); for abstract see *Ceram. Abs.*, **9** [5], 375 (1930). G.R.S.

Location of kaolin deposit. ANON. *Clarksdale* (Miss.) *Register; Rock Prod.*, **34** [19], 99 (1931).—Recently 3500 acres of new kaolin were released in N. C. Drillings indicate a 100-ft. depth for the bed. W.W.M.

Nonmetallic mineral resources of New Jersey. MEREDITH E. JOHNSON. *Pit & Quarry*, **22** [13], 43–50 (1931). E.P.R.

Feldspars of Virginia. R. H. PATTERSON. *Rock Prod.*, **34** [19], 42–45 (1931).—The possibilities of Va. feldspars are discussed. The approximate chemical compositions of better grades of feldspars of Bedford county from the potash area are given as follows:

	Potash feldspar (%)	Average run of mines (%)	Average run soda feldspar (%)
SiO_2	64.00–67.00	67.00–72.00	72.00–75.00
Al_2O_3	17.50–18.50	16.50–18.00	14.75–18.00
TiO_2	0.01– 0.06	0.03– 0.08	Trace
CaO	0.10– 0.50	0.20– 2.25	0.05– 0.10
MgO	0.05– 0.25	0.05– 0.25	0.04– 0.10
Na_2O	2.00– 2.25	1.50– 2.25	7.10– 8.00
K_2O	11.00–12.50	10.00–11.50	0.20– 0.30
Ignition loss	0.10– 0.60	0.10– 0.60	0.30– 0.75

Location, mining methods, and developments in the area are described. W.W.M.

Feldspars. V. CHARRIN. *Céram. Verrerie*, No. 825, pp. 121–22 (1931).—A classification of feldspars is given with chemical analyses and physical properties. C. discusses the occurrence of feldspars and the alteration of feldspars to clays. There is also a discussion of the deposition of clays and subsequent alterations. T.N.McV.

System of silicates. ISTVÁN NÁRAY-SZABÓ. *Acta Lit. ac Sci. Regiae Univ. Hung. Francisco-Josephinae Acta Chem., Mineral. et Phys.*, **2**, 151–61 (1931).—A modification of the system of Bragg has been worked out. Any crystalline silicate of which the chemical composition is exactly known can be placed in a class of this system. Proper places have been found for silicates the structure of which was determined after the working out of this system, *e.g.*, eulytite, enstatite, anthophyllite, natrolite, helvite, etc. See also *Ceram. Abs.*, **9** [12], 1096 (1930). (*C.A.*)

Zirconium oxide, its preparation and uses. H. TRAPP. *Metallbörse*, **21**, 1516–17, 1565 (1931). (*C.A.*)

Philosophic classification of mineral structure. A. C. LANE. *Amer. Mineralogist*, **16** [7], 305–309 (1931).—A discussion is given of the terms applied to the structure, habit, and grain of minerals and their connection with power of crystallization and with the fundamental properties of the arrangement of the atomic network. G.R.S.

Quartz dikes. CARL TOLMAN. *Amer. Mineralogist*, **16** [7], 278–99 (1931).—A review is made of the literature on quartz masses to ascertain if there are any features in their mineral composition or manner of occurrence that might be of diagnostic value in interpreting their origin. G.R.S.

Fluorine and its industrial use in France. V. CHARRIN. *Céram. Verrerie*, No. 825, pp. 123–25 (1931).—Fifty-thousand tons of fluorspar are mined in France, 80% of which is used in metallurgy, 10% in ceramics including glass, and the remainder in the chemical industry. The following specifications are given:

	Minimum (%)	Maximum (%)	
Metallurgy	85 CaF_2	5 SiO_2	
Ceramics	92 "	3 "	5 $CaCO_3$
Chemical industry	97 "	2 "	2 "

A description is given of the various deposits. The world production is U. S. 130,000, England 60,000, France 50,000, and others 35,000. T.N.McV.

BOOKS AND BULLETINS

Outlines of Historical Geology. CHARLES SCHUCHERT. 2d ed. vi + 348 pp. Maps. John Wiley & Sons, New York, 1931. Price $3.60. Reviewed in *Geograph. Jour.*, **78,** 185 (1931).—This is an abridgment of Historical Geology brought up-to-date. H.H.S.

Descriptive Petrography of the Igneous Rocks. Vol. I. A. JOHANNSEN. Univ. of Chicago Press, Chicago. 267 pp. Price $4.50. Reviewed in *Mining & Met.*, **12** [298], 12 (1931).—In this, the first volume of a descriptive petrography, are given definitions of the various textures, a selection of modern methods of classifying rocks, glossaries of general and textural terms, and various tables. E.J.V.

Dielectric Constants and Molecular Structure. C. P. SMYTH. Chemical Catalog Co., Inc., New York, N. Y. Price $4.00. 214 pp. Reviewed in *Can. Chem. Met.*, **15** [9], 50 (1931); *Mining & Met.*, **12** [298], 12 (1931).—S. has correlated and organized the known facts bearing on the problems of electric moment, molecular structure, and intermolecular action and uses them in a critical examination of the theories and hypotheses in terms of which they are interpreted. E.J.V.

A Canadian Geologist: Joseph Burr Tyrrell. W. J. LOUDON. vii + 257 pp. Macmillan, Toronto, 1931. Price $2.00. Reviewed in *Times Lit. Supp.*, **30,** 576 (1931).—T. journeyed across the Barren Lands, was noted for his researches in glacial geology, and endowed a fund for the study of the geology of Canada. H.H.S.

Studies on the origin of Missouri cherts and zinc ores. G. H. COX, REGINALD S. DEAN AND V. H. GOTTSCHALK. *Bull. Mo. School Mines & Met.*, **3** [2], 34 (1916). E.C.C.

Treatise on Missouri clays. MARTIN HARMON THORNBERRY. *Bull. Mo. School Mines & Met.*, **8** [2], 69 (1925).—The analyses, softening points, and discussion relative to production, clay-mining districts, clay-mining methods, and classes and uses of clays from Mo. are given. Detailed methods of making tests and analyses are included. E.C.C.

Quartz and silica. I. General summary. II. Quartz, quartzite, and sandstone. III. Sand and miscellaneous silicas. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, Nos. 6472, 6473, and 6474, respectively. Free. The present paper assembles brief summaries of the many widely differing industries engaged in the production and preparation of these minerals in their principal commercial forms. Part I contains a flow sheet of silica from deposit to consumer. Part II covers the uses and other economic factors of quartz, quartzite, and sandstone, and the varieties of silica found in consolidated form. Part III gives uses, market prices, and other information on fused-silica glass, silicon carbide, building sand, paving sand, sand-lime brick, molding sand, tripoli, diatomite, etc. R.A.H.

Geophysical Abstracts. XXVIII. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6547. 25 pp. Free. This report is a monthly review of publications on geophysics. It makes note of new books and patents. For Part XXVII see *Ceram. Abs.*, **10** [11], 805 (1931). R.A.H.

Chemistry and Physics

Determination of iron in silicates. SHIGEYUKI SHINKAI. *Jour. Jap. Ceram. Assn.*, **37** [433], 24–27 (1929).—In the volumetric analysis of iron in silicates, the solution of the cake of potassium pyrosulphate often becomes turbid and black while it is being reduced with granular zinc. S. has quantitatively ascertained that the black substance is platinum black produced by the reduction of platinum sulphate due to the

dissolution of the platinum crucible by nascent hydrogen. The turbidity can be avoided by precipitating hydroxides of aluminum and iron from the solution of the cake with ammonia. See also *Ceram. Abs.*, **10** [1], 70 (1931). S.K.

Study of silicate analysis. II. New method of determining silica, alumina, and ferric oxide. SHIGEYUKI SHINKAI AND AYAO HAMASAKI. *Jour. Jap. Ceram. Assn.*, **37** [442], 435–37 (1929).—The effect of the alumina content in the sample on the amount of silica as given by the new method described in the first report has been studied. Conclusions are as follows: (1) The molecular ratio of alumina to silica in samples must be greater than 1:14.9 for the new analytical method. (2) In samples which are too poor in alumina, *e.g.*, quartz sand or glasses of certain types, suitable amounts of about $N/10$ solution of $AlCl_3$ must be added to satisfy the above requirements. For Part I see *Ceram. Abs.*, **10** [5], 384 (1931). S.K.

Precipitation of potassium and sodium according to the perchlorate method and its use in the silicate analysis. FRIEDRICH ZAPP AND ALFRED HEINZ. *Keramos*, **10** [16–17], 427–32 (1931).—The method used by Schlösing and Wense is discussed and it is pointed out that the conversion of chlorides into perchlorates in the presence of large quantities of sodium requires great care. If chlorides are present, the entire sodium residue remains in the potassium residue because of the insolubility of NaCl and KCl in absolute alcohol, and the method gives too high values. The factors affecting the method of separation were investigated and it was determined how far different potassium contents and other perchlorates may influence the results. It was found that $NaClO_4$ is readily and completely soluble, $KClO_4$ is insoluble, $Ca(ClO_4)_2$ is completely easily soluble, $Mg(ClO_4)_2$ is completely soluble, $Al(ClO_4)_3$ is easily soluble, $Fe(ClO_4)_3$ is soluble in large quantities of alcohol, and NH_4ClO_4 is easily soluble. This shows that it is possible to undertake the perchlorate separation of potassium not only from sodium but also from all the other alcoholic perchlorates in the same sample. Feldspars and silicates containing feldspar were analyzed as follows: The loss on ignition is determined. One gram of the dried sample is treated with 2 g. of chemically pure soda; the SiO_2 is separated and the filtrate poured into a 500 cc. measuring flask. One hundred or 200 cc. of the filtrate are used for determining Al_2O_3, Fe_2O_3, CaO, and MgO in the normal way. Two hundred grams of the filtrate are used for determining potassium. The peptized solution is treated with a chemically pure 60% $HClO_4$ solution, then evaporated on a water bath and air bath and stirred till the residue seems to be evenly moistened. After cooling, the residue is dissolved in boiling water, a small quantity of perchloric acid added, evaporated to dryness as before, and again dissolved in hot water; some perchloric acid is added, a third time evaporated, and cooled. The crystals are crushed and digested with 97% alcohol so that almost the whole quantity of salts goes into solution. The undissolved perchlorates deposit rapidly and the pure solution is absorbed by a filter crucible. The salts remaining in the bowl are practically free from potassium and aluminum and are again dissolved with hot water, the alcohol evaporated first over the water bath, then again evaporated to dryness with 1 to 2 cc. $HClO_4$ and digested in alcohol. The residue composed of pure $KClO_4$ is filtered through the filter crucible, washed with alcohol containing $HClO_4$, dried at 120 to 130°, and weighed. The sodium content of the sample is ascertained from the difference from 100% which is sufficient. The separation of $KClO_4$ from the filtrate can also be made with ammonia after the precipitation of alumina and other sesquioxides. This is recommended especially with a greater per cent content of iron, titanium, and other impurities. This method gives great economy in time and sufficient exactness for technical purposes. M.V.K.

Semi-microchemical determination of alkali metals in natural waters (bore waters) and silicates. K. L. MALYAROV. *Neftyanoe Khozyaistvo*, pp. 223–25 (1930); *Chem. Zentr.*, **II**, 771 (1930); for abstract see *Ceram. Abs.*, **9** [6], 470 (1930). (*C.A.*)

Mechanism of absorption of water during heating by ceramic bodies. J. ANDRE LAVERGNE. *Rev. mat. constr. trav. pub.*, No. 262, pp. 125–27*B* (1931).—From the experimental evidence obtained by immersing a brick in cold water, by immersing in cold water and heating to the boiling point, and by immersing a cold or a heated brick in boiling water, L. concludes that (1) water penetrates the ceramic body only in the course of cooling, (2) while boiling continues, saturation of the body is not possible, and (3) there is, properly speaking, no absorption in the course of heating or at the boiling temperature. See also *Ceram. Abs.*, **9** [8], 678 (1930). M.Y.H.

Clay colloids and their use in ceramics. R. DUBRISAY. *Feuerfest*, **7** [7], 108 (1931); for abstract see *Ceram. Abs.*, **10** [10], 732 (1931). M.V.K.

Water relationships in colloids. I. Vapor pressure measurements on elastic gels. D. R. BRIGGS. *Jour. Phys. Chem.*, **35** [10], 2914–29 (1931).—The isotenoscope method for measuring vapor pressure of liquids is found to be a quick method applicable to the determination of the activity coefficient of water contained in colloids. G.R.S.

Analysis of clays. ORAZIO REBUFFAT. *Giorn. chim. ind. applicata*, **13** [8], 368–69 (1931).—A process for separating pure hydrosilicate of alumina from the other components of clays is described. Although long and delicate it can be used for analyzing small quantities of substance and gives results which have not been obtained by other methods. It is based on the various capacities of amorphous silica and different silicates of alumina to pass into the dispersed state and also on the stabilities of the dispersions which can be obtained. If a jell of silica and a jell of hydrosilicate of alumina are subjected to deflocculation under identical conditions and the weights of the dispersed substances contained in equal volumes of each liquid are determined (at the same temperature), it is found that the quantity of silica is much greater than that of the hydrosilicate of alumina. If a mixture of silica jell and hydrosilicate of alumina are subjected to the action of a limited quantity of a deflocculating liquid, the silica goes into the liquid in greater proportions than the hydrosilicate of alumina. The composition of the part which does not pass into the dispersed state changes rapidly, however, always remaining richer in hydrosilicate of alumina, while the silica accumulates in the part which has passed into dispersion. Furthermore, the deposition of the dispersed parts does not occur homogeneously because the hydrosilicate of alumina separates out (flocculates) first, and after a longer time, the silica. The course of the separation can be followed in its fundamental lines by determining the water of hydration of the different fractions obtained. The experiment has shown that flocculated silica (from a dispersion of silica jell) dried at 110° does not retain the water of hydration, while the different silicates of alumina dried at the same temperature retain all or a large part of their own water of hydration. As a consequence, by subjecting a mixture of silica jell and hydrosilicate of alumina to the process of fractionated dispersion, the variation of the per cent of water of hydration of the different fractions obtained indicates clearly the course of the separation of the silica from the hydrosilicate of alumina. The per cent of the water of hydration is seen to increase in the successive fractions obtained (which are always poorer in free silica) until a maximum is reached which remains constant. In analyzing fractions brought to the maximum per cent of water of hydration, it is found that the hydrosilicate of alumina contains small quantities of mica and feldspar with traces of lime, magnesia, and alkali, which, because of their small quantity, were not entirely removed by the levigation. The greater part of these substances remains in the residue in the process of fractioning. To eliminate them, the different fractions containing maximum water of hydration are again subjected to deflocculation and the deposits which form are fractionated. The last fraction will give the hydrosilicate of alumina of the greater purity. M.V.K.

Observations on clay suspensions as emulsifying media with particular reference to

aqueous alcoholic suspensions. R. M. WOODMAN AND E. MCK. TAYLOR. *Chem. News*, **143** [3725], 145–49; [3726], 161–65 (1931).—China clay and fullers' earth in the natural state are mainly water-in-oil emulsifiers for various true oils and fatty acids. The tendency to form oil-in-water types is small. Calcium-saturated and completely-unsaturated bentonites in aqueous alcoholic suspensions form aqueous alcohol-in-oil types with linseed oil containing free oleic acid. There is a definite emulsification of traces of oils at certain phase-volume ratios. Bentonite and sodium-saturated bentonite in aqueous alcohol suspensions yield both types of emulsions with this "acid" linseed oil. G.R.S.

Measurement of small particles. W. L. GADD. *Cement & Cement Mfg.*, **4**, 763 (1931).—An "obscurometer" for determining the average diameter of particles contained in a fine powder is described. The method has been applied to coal, cement, sand, and powdered glass and results obtained have been in good agreement with results obtained by measuring particles under the microscope. W.L.

Calculation of ceramic bodies, glaze, glass, and enamel in practice. V. LOKSCHIN. *Building Sci. Abs.* [N.S.], **3**, 117; for abstract see *Ceram. Abs.*, **10** [1], 22 (1931). (*C.A.*)

Alcoholic method for determining moisture content of soils. G. BOUYOUCOS. *Soil Sci.*, **32** [3], 173–78 (1931).—The determination of moisture is made rapidly. If the method is properly used it is accurate and reliable. Mechanical dispersion of the soil was accomplished by means of a milk-shaking machine. G.R.S.

Plasticity of ceramic pastes. ANGELO CASTIGLIONI. *Chem. Zentr.*, **102** [6], 893 (1931).—Good results are obtained with a flocculation agent consisting of tannin, soda, and Na-silicate. See also *Ceram. Abs.*, **10** [10], 732 (1931). J.G.T.

Thermal expansion of raw and fired clays. HERMANN SALMANG AND ANDREAS RITTGEN. *Chem. Zentr.*, **102** [11], 1618 (1931); for abstract see *Ceram. Abs.*, **10** [11], 810 (1931). J.G.T.

Decreasing the noxious effects of lead glazes for faience. V. V. VARGIN AND L. L. FRADKOVA. *Ceramics & Glass*, **7** [5], 29–34 (1931).—The influence of SiO_2, Al_2O_3, B_2O_3, PbO, and CaO on the acid stability of frits used for preparing lead glazes for faience was studied. The results are tabulated. M.V.K.

Clays as minerals and as colloids. C. E. MARSHALL. *Trans. Ceram. Soc.* [Eng.], **30** [3], 81 (1931); for abstract see *Ceram. Abs.*, **10** [5], 381 (1931). C.G.H.

Importance of crystallographic changes in silica in its reactivity in the solid state. I. J. ARVID HEDVALL AND PER SJÖMAN. *Z. Elektrochem.*, **37**, 130–42 (1931); for abstract see *Ceram. Abs.*, **9** [8], 676 (1930). (*C.A.*)

The system wollastonite-anorthite-pyroxene. A contribution to the knowledge of slags. LEO KOCH. *Neues Jahrb. Mineral Beil.*, **61**, 277 (1930); *Glastech. Ber.*, **8**, 543*A* (1930).—An attempt was first made to establish the approximate equilibrium diagram for the ternary system calcium silicate-anorthite-diopside, employing the results of N. L. Bowen and G. A. Rankin for the binary systems diopside-anorthite and calcium silicate-anorthite. Koch interprets his results in terms of the quaternary system SiO_2-Al_2O_3-CaO-MgO and discusses the relative positions in this phase model of the acid and basic mixtures which he previously found in many types of slags in which the silica existed as cristobalite and tridymite, with the part system calcium silicate-anorthite-diopside. (*J.S.G.T.*)

Applications of ceric sulphate in volumetric analysis. IX. Standardization of thiosulphate solutions. N. H. FURMAN AND J. H. WALLACE, JR. *Jour. Amer. Chem. Soc.*, **53** [3], 1283–88 (1931); for Part VIII see *Ceram. Abs.*, **10** [1], 70 (1931). R.G.M.

Electric gas purification as a consequence of the electric wind. W. DEUTSCH.

Ann. Physik, **9** [2], 249–64 (1931).—Ladenburg and Tietze (see *Ceram. Abs.*, **10** [10], 734 (1931)) believe that electric purification of gases is due to a combined action of pure electric forces and the electric wind. D. concludes from the behavior of cleaning installations in actual plant work that this cannot be the case. The main purification is due to pure electric forces, whereas the electric wind has only a secondary influence, keeping the dust particles in suspension. W.M.C.

Drying compressed air. ANON. *Emaillewaren-Ind.*, **8** [32], 252 (1931); for abstract see *Ceram. Abs.*, **10** [6], 443 (1931). M.V.K.

Further investigation of the magnesia zircon series based on X-ray and microscopic examination. A. L. ROUSSIN AND J. H. CHESTERS. *Trans. Ceram. Soc.* [Eng.], **30** [6], 217 (1931).—A series of briquets were made of mixtures of magnesite and zircon. The materials used were commercial Radentheim magnesite and commercial zircon, so that the reactions are complicated by the presence of impurities in addition to the 5% clay bond used. X-ray photos and photomicrographs accompany a discussion of each mixture. The phases reported are as follows: (zircon); (zircon + *X*); *X*; (*X* + *Y*); (*Y*) (*Y* + magnesia); (magnesia). *X* and *Y* are thought to be approximately $MgO–ZrO_2–SiO_2$ and $4MgO–ZrO_2–SiO_2$, respectively. The optical properties of the ternary compounds are not reported. C.G.H.

Application of X-ray crystal analysis to industrial problems. ANON. *Dept. Sci. Ind. Research* [London], 1931; reviewed in *Mech. World*, **90** [2333], 275 (1931).—The most effective means for the application of X-ray methods to industrial problems involves a close coöperation between the X-ray worker and the specialists in the other sciences. To carry such coöperation into effect, suitable officers of the National Physical Laboratory have been detailed for temporary work in selected industrial centers or in laboratories of research associations. W.L.

German patents on zinc oxide. H. MEIER. *Farben-Ztg.*, **36**, 1560–61 (1931).—Abstracts of 57 German patents dealing with ZnO are given. E. KLUMPP. *Ibid.*, 1773–74.—The economics and the chemistry of the preparation of ZnO are discussed. The two principal processes are the retort and the hearth. The former produces the purest material if Zn metal is used. (*C.A.*)

Migration studies with ferric oxide sols. I. Positive sols. F. HAZEL AND G. H. AYRES. *Jour. Phys. Chem.*, **35** [10], 2930–42 (1931).—Migration velocity of positive ferric oxide sols was studied by observation of the movement of single particles under the ultramicroscope. The effect of hydrogen-ion concentration and of addition of electrolytes on the migration velocity were studied. G.R.S.

Melting points of the easily melting alumino- and boro-silicates. M. NEKRITSCH. *Sprechsaal*, **62**, 699 (1929); *Jour. Soc. Glass Tech.*, **14**, 9*A* (1930).—N. repeats and extends the work of Kai-Ching Lu (see *Ceram. Abs.*, **5** [2], 65 (1926)) on the softening temperature of various ternary eutectics formed by Pb, K, and Na alumino- and boro-silicates. The method consisted in melting together the components in the eutectic composition given by Kai-Ching Lu, and noting the formation temperature of the glass. The melt was ground and a Seger cone formed from the powder. The deformation temperature of this was then noted. The following results were obtained:

Composition	Melting point		Formation temperature
	Nekritsch	Kai-Ching Lu	
(1) PbO, $0.238B_2O_3$, $0.78\ SiO_2$	485°	415°	750°
(2) PbO, $0.254Al_2O_3$, $1.91\ SiO_2$	790	650	1150
(3) Na_2O, $1.29\ B_2O_3$, $1.73\ SiO_2$	630	570	800
(4) K_2O, $2.11\ B_2O_3$, $2.585SiO_2$	820	655	1100

In regard to the influence of Al_2O_3 on the melting point of Pb silicates, Kai-Ching Lu found regular increase in the melting point with successive additions. (*C.A.*)

Simple electrodialysis cell for routine determination of exchangeable bases in soils. M. L. M. SALGADO AND G. W. CHAPMAN. *Soil Sci.*, **32** [3], 199–215 (1931).—A simple and cheap two-compartment continuous-flow type of electrodialysis cell, well suited for routine determinations of exchangeable bases of soils, is described. Results obtained with four types of soils are discussed. G.R.S.

Methods of analysis of Portland cement and raw materials from which it is made. FRANK C. MORAN. *Rock Prod.*, **34** [20], 44–45 (1931).—A number of original procedures are included. Methods are given for the analysis of the raw mix, clinker analysis, cement analysis, ignition loss on raw rock and cement, ignition loss for gypsum, gypsum analysis, limestone analysis, and standardization of solutions. W.W.M.

Recent investigations on the constitution of ceramics and cements. G. MALQUORI. *Ann. chim. applicata*, **21**, 170–82 (1931); for abstract see *Ceram. Abs.*, **10** [2], 148 (1931). (*C.A.*)

Adsorption method for the determination of the area of a powder. WM. D. HARKINS AND DAVID M. GANS. *Jour. Amer. Chem. Soc.*, **53**, 2804–2806 (1931).—The powder is dried in a high vacuum at as high a temperature as can be used without affecting the area of the crystal. The cool, dry powder is immersed in a solution of oleic acid, butyric acid, or some other suitable acid in dry C_6H_6 and the suspension is shaken until equilibrium is attained. The oleic acid in the supernatant liquid and in the initial solution is determined and the difference in concentration is considered to give the amount of acid adsorbed by the surface of the powder. At concentrations above 0.01 to 0.02 molecule of oleic acid per kg. of C_6H_6, the adsorption becomes practically constant and the acid on the surface of the grains of powder may be said to form a condensed film, which may be monomolecular. The area of TiO_2-I is calculated to be 22.9 m.^{2} per cc. of TiO_2 and for TiO_2-II, 14.4 m.^{2} per cc. (*C.A.*)

Glass electrode determination of sodium in NaCl-KCl mixtures. F. URBAN AND A. STEINER. *Jour. Phys. Chem.*, **35** [10], 3058–62 (1931).—The glass used had the following percentage composition: 70Li_2O, 15Na_2O, K_2O, small amount, 6CaO, MgO, Al_2O_3, HBO_2, Fe_2O_3, and 9BaO. The method for the determination of sodium is outlined and an equation for the mixed electrode potential is developed. G.R.S.

Limestone analysis. H. RITTER. *Sprechsaal*, **64** [37], 683–84 (1931).—Different methods were tried to determine the amount of calcium and magnesium contained in a commercial limestone sample. For calcium the ignition and titration analyses gave higher values than for determining calcium oxalate. This was caused by the presence of magnesia in the sample which could not be separated by the two methods first mentioned. The best method to determine magnesia is by the use of hydroxyquinoline which affords only a small amount of material and which is quick and simple. W.M.C.

BOOKS AND BULLETIN

Standards and specifications for nonmetallic minerals and their products. JOHN Q. CANNON, JR., AND A. S. MCALLISTER. Supt. of Documents, Washington, D. C. $2.75. Bur. Stand., *Misc. Pub.*, No. 110, 680 pp. (1930).—This volume represents an attempt on the part of the Dept. of Commerce to collect and publish the substance of the standards and specifications relating to nonmetallic minerals and manufacturers thereof, formulated by the national technical societies, the trade associations having national recognition, or other organizations which speak for industry or with the authority of the Federal Government as a whole. The following groups are covered in the different sections: (1) coal, petroleum, and mineral wax, (2) stone, sand, and cementitious materials, (3) glass and glass products, (4) clay and clay products, (5) abrasive materials, asbestos, and chalk, (6) mica and rare minerals, (7) precious stones and imitations, (8) sulphur, magnesia, salt, and graphite, (9) other nonmetallic minerals (fluorspar and

cryolite, feldspar, and silica), (10) societies and associations issuing standards and specifications dealing with nonmetallic minerals. R.A.H.

Use of Units in the Practice of Calculation. (L'Emploi des Unités dans la Pratique des Calculs.) F. BÉTRANCOURT. Dunod, Paris, 91 pp. 16 F. Reviewed in *Mining & Met.*, **12** [298], 12 (1931).—This is a collection of the geometrical, mechanical, electrical, magnetic, and optical units of measurements, with definitions, formulas, etc., intended as an aid to calculators. E.J.V.

Elements of Chemical Engineering. WALTER L. BADGER AND WARREN L. MCCABE. *Jour. West. Soc. Eng.*, **36** [4], 252 (1931); for abstract see *Ceram. Abs.*, **10** [5], 391 (1931). W.W.M.

Monograph of Viscosity. G. BARR. Humphrey Milford, Oxford Univ. Press, London, 1931. 318 pp. Reviewed in *Chem. & Ind.*, **50** [35], 729 (1931); *Analyst*, **56**, 496 (1931); for abstract see *Ceram. Abs.*, **10** [9], 665 (1931).

Physical Properties of the Soil. B. A. KEEN. Reviewed in *Chem. & Ind.*, **50** [36], 742 (1931); see also *Ceram. Abs.*, **10** [11], 805 (1931). G.R.S.

Effect of addition agents in flotation. I. MARTIN HARMON THORNBERRY AND HORACE THARP MANN. *Bull. Mo. School Mines & Met.*, **4** [2], 48 pp. (1917). **II.** *Ibid.*, **5** [2], 68 pp. (1919). E.C.C.

Reduction of zinc oxide by carbon. G. A. ZELLER AND B. M. O'HARRA. *Bull. Mo. School Mines & Met.*, **8** [1], 32 pp. (1924).—In the first part of this paper the results obtained by the various investigators are reviewed. It is indicated that 800°C is the temperature at which continuous reduction first becomes possible under a pressure of one atmosphere, though it does not attain a readily detectable rate until considerably higher temperatures are reached. In the second part of the paper it is shown that at temperatures above that at which reduction of the zinc first becomes noticeable the rate of reduction doubles with approximately equal intervals of temperature, the intervals differing for different forms of carbon. The gradual decrease in the rate of reduction during the distillation of a given charge, in the case of pure zinc oxide, is not caused by any changes brought about in the zinc oxide itself by the prolonged heating causing it to be less easily reducible, but is a direct function of the amount of zinc remaining in the charge. Experiments showed very little difference in the reducibility of the different forms of pure or nearly pure zinc oxide, with the exception of that resulting from the calcination of the natural zinc carbonate and smithsonite which was reduced much more rapidly than the other forms tested. Although the differences in reducibility were small, the forms of zinc oxide that had previously been heated to the highest temperatures were, in general, reduced at the slowest rate. In all the groups of experiments the variation in the rate of reduction with different forms of carbon is shown at various temperatures and with various forms of zinc oxides. The authors believe that the differences in the rate of reduction of different forms of zinc oxide and by different forms of carbon are due mainly to differences in the surface conditions of the zinc oxide or carbon particles, and that there are probably no great differences in the temperatures at which reduction of the different varieties of zinc oxide or by the different varieties of carbon first begins. There is, however, no convincing evidence on this point. E.C.C.

PATENTS

Obtaining barium orthosilicate or barium trisilicate by the decomposition of barium carbonate. FRITZ ROTHE AND HANS BRENEK. U. S. 1,824,298, Sept. 22, 1931. The process for obtaining barium orthosilicate or barium trisilicate by the decomposition of barium carbonate comprising heating barium carbonate together with silica-containing material in the presence of steam.

Removal of impurities from sand, clay, etc. JOHN ENGLISH. U. S. 1,824,807, Sept. 29, 1931. Method which consists in heating the materials to a temperature of

700 to 1000°C and while so heated subjecting the materials to the action of a reducing gas and chlorine, the chloride formed being afterwards removed from the gas.

Extraction of impurities from quartz, silicates, and clay. W. W. TRIGGS. Brit. 356,145, Sept. 16, 1931.

Removing iron from sand, etc. SOC. DES PRODUITS CHIMIQUES "ALTERRA" S. A. Fr. 705,281, Nov. 8, 1930. Fe is removed from sand, clays, and other minerals containing Fe by treatment with a mixture composed of dilute H_2SO_4 and $FeSO_4$. (*C.A.*)

Drying clayware. SOKITI ISIKAWA. Japan. 90,751, March 24, 1931. Addition to 78,611. A clay having large adhesive power is treated with HCl containing $NaNO_3$ and one or more of the sulphates of Na, K, Al, Fe, and Mg. It is properly shaped and roasted at 200 to 250°. (*C.A.*)

General

Rock wool. M. F. GOUDGE. *Can. Chem. Met.*, **15** [9], 245 (1931).—Rock wool, one of the most effectual and satisfactory insulating materials on the market, is a furnace product made by fusing dolomite. Rock wool fibers are obtained from natural rock or mixture of rocks having a chemical composition as follows: 24–32% silica, 2–3% ferric oxide, 8–12% alumina, 16–21% calcium oxide, 10–13% magnesium oxide, and 26–29% volatile matter. The rock is melted in a small cupola furnace at between 2800°F and 3300°F and is atomized by steam. It is used as insulating material up to 1000°F and is the main ingredient in acoustic tile. E.J.V.

Swelling and working state of clays. L. A. SHMELEV. *Ceramics & Glass*, **7** [5], 21–23 (1931).—S. discusses the influence of ceramic pastes and the swelling of clay on the quality and quantity of wasted ware and points out that if the paste contains more water than a normal paste, the excess water separates the particles and causes a higher air shrinkage and consequently, a greater waste of ware during drying. On the other hand, if the paste contains less water than normal, the water forms pores which are not filled with water. This may promote a higher porosity in the dried and fired ware. It is concluded that the quantity of water in a working paste must completely fill up the pores in order to prevent a greater waste of ware. M.V.K.

Precautions when blasting brick-earth. ANON. *Brit. Clayworker*, **40** [473], 213 (1931).—Brick-earth in the form of shale or indurated clay is often cheaper to loosen by explosives than by any other means. Collections at the foot of the face must not be allowed to remain for they are apt to divert the direction in which the explosive acts. The more vertical the face the better will be the action of the explosive and the wider the face the larger will be the quantity of the material loosened at one blasting. The ideal height of the face or bench is 25 to 28 ft. Boreholes should not be more than $2^1/_2$ to $3^1/_4$ in. wide and should not be more than $^1/_2$ to $^1/_4$ in. wider than the cartridges used for blasting. Too much explosive should be avoided and under no circumstances should it occupy more than $^2/_3$ of the hole. Electric detonators are far better than fuses. R.A.H.

Sodium aluminate in modern water treatment. R. B. BEAL AND S. STEVENS. *Chem. & Ind.*, **50** [34], 307–13 (1931).—The principal properties of sodium aluminate are outlined and its uses in water treatment are discussed. G.R.S.

Comparison of power costs of steam, gas, oil, and electricity as applied to a pottery. H. S. NEWMAN. *Trans. Ceram. Soc.* [Eng.], **30** [7], 244–57 (1931); for abstract see *Ceram. Abs.*, **10** [6], 465 (1931). C.G.H.

Quality control system in a porcelain insulator plant. E. H. FRITZ. *Bull. Amer. Ceram. Soc.*, **10** [10], 313–18 (1931).—Details of the control methods used in the various steps involved in the production of porcelain insulators are given and the value of such a quality-control system is discussed. E.J.V.

Data. I. T. W. GARVE. *Clay-Worker*, **96** [3], 164 (1931).—This is the first of a series presenting compilations of data of interest to the clayworker, consisting mainly of the more common equivalents of standard units and some definitions. E.J.V.

Fundamentals and economies in the clay industries. VIII. ELLIS LOVEJOY. *Clay-Worker*, **96** [3], 152–54 (1931).—A notable economy in clay mining is to have it independent of the factory operation and thus to permit the work to be carried out at a maximum rate. Some examples from actual operations are cited to illustrate the problems which must be solved in clay mining. A map of the clay properties showing all possible details is of great value in the proper layout of a clay mine or pit. Clay mining divides into two classes: (1) open pit, in which the work divisions are (*a*) stripping, (*b*) drainage, (*c*) winning, and (*d*) mixing, and (2) underground mining, divisible into (*a*) room and pillar, (*b*) block mining, (*c*) long wall, and (*d*) stoping. The first three of the latter subdivisions apply to beds that are level or but slightly inclined, while stoping is used in steeply inclined beds. Detailed discussions of stripping and drainage are presented. For part VII see *Ceram. Abs.*, **10** [10], 737 (1931). E.J.V.

Bentonite in ceramic manufacture. ANON. *Brick Clay Rec.*, **79** [6], 266 (1931).—A brief discussion of the properties of bentonite in ceramic bodies, as observed in experiments conducted by the American Colloid Co., Chicago, producers of Volclay, a bentonite clay, is presented with some of the data obtained. E.J.V.

History of science: International Congress. H. T. PLEDGE. *Discovery*, **12**, 254–56 (1931).—The study of the history of science has only recently become recognized as an integral part of research. The recent congress in London is discussed, and the importance of analyzing past methods in attacking new problems is stressed. H.H.S.

Mechanized glass and brick factories in U.S.S.R. ANON. *Econ. Rev. Soviet Union*, **6** [18], 427 (1931).—One of the largest glass factories in the world, the "Pioneer," was completed in July at Misherony in the Moscow region. The 12 machines have a daily output of 6340 square meters of high-grade building and automobile glass. A completely mechanized brick plant with a capacity of 40 million brick was recently completed at Petrovchina (near Minsk) in White Russia. M.V.K.

Economics of the nonmetallic mineral industries. VIII. Sales methods. RAYMOND B. LADOO. *Rock Prod.*, **34** [20], 31–33 (1931); for Part VII see *Ceram. Abs.*, **10** [11], 813 (1931). W.W.M.

Profit-making concept of budgetary control. I, II, and III. RALPH N. HARRIS. *Factory & Ind. Management*, **82** [1], 44–46; [2], 203–205; [3], 331–33 (1931).—A study of plant capacity and the development of an operating schedule in the preparation of a budget for a glass-manufacturing plant is described. E.C.C.

"Keeping books" on sewer pipe. R. LOGIE. *Jour. Accountancy*, Sept., 1931; *Brick Clay Rec.*, **79** [6], 264–66 (1931). E.J.V.

Accident hazards present in shipping, packing, and storing cement. R. H. MACFETRIDGE AND STEWART J. OWEN. *Pit & Quarry*, **22** [12], 47–52 (1931).—Screw conveyers and sliding materials are among the leading hazards. E.P.R.

Summer meeting of American glass technologists. ANON. *Glass Ind.*, **12** [10], 201–203 (1931); *Bull. Amer. Ceram. Soc.*, **10** [10], 319–21 (1931).—A detailed report of the meeting held at Old Point Comfort, Va., Sept., 1931, is given. Illustrated. E.J.V.

Glass Container Association meeting, August, 1931. ANON. *Ceram. Ind.*, **17** [4], 306–10 (1931). W.W.M.

Meeting of the brick industry at the Leipzig fair. ANON. *Tonind.-Ztg.*, **55** [72], 1019–21 (1931).—Papers were read which covered building, manufacture of brick, and economical problems. W.M.C.

Glass and china. G. E. PAZAUREK. *Sprechsaal*, **64** [37], 684–85 (1931).—The

exposition held at Stuttgart is criticized with regard to the prevalence of machine-made products shown. W.M.C.

BOOKS AND BULLETINS

Handbook for Prospectors. M. W. VON BERNEWITZ. 2d. ed. McGraw-Hill Book Co., Inc., N. Y., 1931. 359 pp. $3.00. Reviewed in *Amer. Mineralogist*, **16** [8], 342–43 (1931).—One-half of the book is devoted to a discussion of the most common nonmetallic and metallic minerals in reference to their occurrence, description, detection, use, and value. B. assumes that the reader has had no basic training in mineralogy and geology and therefore attempts to present the subject matter in such terminology and simplified classification that the layman may readily understand it. G.R.S.

Materials and Structures. Vol. 1. The Elasticity and Strength of Materials. E. H. SALMON. Longmans, Green & Co., London. Price 15s net. Reviewed in *Engineering*, **132** [3421], 156 (1931). A.A.

Flotation in Theory and Practice. (Die Flotation, in Theorie und Praxis.) W. LUYKEN AND E. BIERBRAUER. J. Springer, Berlin. 284 pp. Price 29 Rm. Reviewed in *Mining & Met.*, **12** [298], 12 (1931).—After a historical chapter, the theory of flotation is discussed. Several typical flotation plants are described. E.J.V.

Flotation reagents, 1929. T. H. MILLER AND R. L. KIDD. Bur. Mines, *Rept. of Invest.*, No. 3112, 20 pp.—This paper is the seventh of a series of yearly reviews started in 1921 and presents flotation reagent consumption data. The total consumption of reagents expressed in pounds per ton of ore treated decreased over 4% and the trends indicated are (1) decreased consumption of frothing reagent, (2) substitution of synthetic collectors for distillation collectors, (3) more extensive use of butyl and amyl xanthates, (4) introduction of aliphatic dithiophosphates, and (5) more extensive use of alkaline circuits. See also *Ceram. Abs.*, **9** [11], 989 (1930). R.A.H.

Building Materials and Corrosion. (Werkstoffe und Korrosion.) **I. Metallic building materials. II. Nonmetallic materials.** ERICH RABALD. Otto Spamer, Leipzig, 1930. 128 Rm. Reviewed in *Keramos*, **10** [16–17], 440–41 (1931).—R. discusses glass, earthenware, vitrified ware, steatite, and their properties; the use and protection of refractory materials in the chemical industry, steamboilers, electric kilns, gas works, and metallurgy; artificial resins, artificial stones and masses, mortar, brick, quartz glass, quartz ware, and concrete. M.V.K.

Report of the Department of Scientific and Industrial Research for the year 1929–30. ANON. *Dept. Sci. Ind. Research* [London], 1931; *Mech. World*, **89** [2308], 293 (1931).—This annual report reviews the work for the current year. The problems investigated are as follows: (1) *Building Materials.* (*a*) Weathering of building materials involves a knowledge of the factors which control the movement of moisture through the porous material and its evaporation from the exposed surface, the action of acid sulphur gases on limestone, and the resultant formation of surface skins. Cleaning of buildings and other remedial measures have been studied. (*b*) The efficiency of building materials includes data on dust films and their effect on the ultra-violet transmission of special window glasses and whitewashing and its effect on the amount of solar heat transmitted by a glass roof. (2) *Atmospheric pollution.* Reports are given on routine methods of measuring the amount of sulphur in the atmosphere and means of measurement of daylight. (3) *X-ray analysis of crystals.* Experiments were made on types of apparatus with a view to decreasing the time of exposure necessary to obtain X-ray diffraction patterns, and developing an apparatus to give a truly monochromatic source of light. W.L.

The Engineer's Yearbook, 1931. 38th ed. 3042 pp. Morgan Bros., Ltd. ("The Engineer"), London, 1931. Price 31s 6d. This book is a useful compendium of the

modern practice of civil, mechanical, electrical, marine, gas, aero, mine, and metallurgical engineering. H.H.S.

International Congress for Testing Materials. ANON. *Keramos*, **10** [15], 391 (1931); for reports see *Ceram. Abs.*, **10** [5], 397; [8], 544, 586 (1931). M.V.K.

Study of falls of roof and coal in mines in Harrison county, W. Va. J. W. PAUL AND J. N. GEYER. Bur. Mines, *Rept. of Invest.*, No. 3110, 30 pp.—This is one of three papers giving results of a study of safeguards employed in coal mines to protect workmen from falls of roof and coal. Features and practices found to promote protection are summarized and additional safeguards are suggested. R.A.H.

Sulphur compounds in water and their removal. Fuel Research Paper No. 31. W. E. BAKES, J. G. KING, AND F. S. SINNATT. H. M. Stationery Office, London. Price 9d (18¢). Reviewed in *Gas Age-Rec.*, **68** [13], 460 (1931).—Various methods for such removal are reviewed. E.J.V.

PATENTS

Continuous process for preparation of kaolin and clay. ERICH MÜLLER. Ger. 516,144, C1808, Dec. 30, 1926; *Chem.-Ztg.*, **55** [75], 177 (1931).—Into the washing apparatus, Na water glass of 36 to 38° Bé and fresh water are supplied in constant proportion to the weight of the raw material till streaks are formed on the surface of the suspension. The suspension is neutralized with HCl on flowing out of the apparatus and treated in the usual way. See also *Ceram. Abs.*, **10** [10], 720 (1931). J.G.T.

Manufacture of ceramic ware, layers, and street surfaces. ÁGOST VÉRTESS. Hungarian 101,366, March 18, 1930. Ceramic raw material, melting at about 1100 to 1500 (rocks, silicates, etc.) is melted and poured into forms or over the surface of soil. The poured layer may be covered with sand, ash, and gravel. The melting furnace described can be built on the chassis of a car. (*C.A.*)

Book Reviews

Economic Control of Quality of Manufactured Product. W. A. SHEWHART. xiv + 501 pp. $6.50. D. Van Nostrand Co., Inc., New York, 1931. Reduced costs and improved quality are vital to the success of every industry and every technical man. This book gives definite statistical methods to attain these objects. It explains all the necessary mathematics in the simplest possible terms. It provides a practical ready means for the mastery and application of present-day methods of quality control. This information has the greatest direct value in obtaining the maximum benefits of quantity production, in the reduction of the costs of inspection and rejection, and in achieving many other objects of equal importance.

Colloid Chemistry in Ceramics. (Kolloidchemie in der Keramik.) HANS KOHL. Theodor Steinkopff, Dresden and Leipzig, 1931. 51 pp. 20 illustrations. 4.00 Rm. This book is a comprehensive survey of the use of colloid-chemical investigations and work methods in ceramics. The following subjects are treated: (*A*) *General ceramics:* (1) raw materials: (*a*) plastic raw materials, their origin, classification, and properties, (*b*) grain size, (*c*) behavior in suspension, (*d*) plasticity, (*e*) capability of molding, (*f*) drying, shrinking, and behavior of dried clays, (*g*) behavior of clays during firing, (*h*) nonplastic raw materials, and (*j*) researches on raw materials; (2) classification of clayware; (3) preparation of ceramic pastes and their testing: (*a*) coarse ceramic pastes, (*b*) fine ceramic pastes, (*c*) molding pastes, and (*d*) stamping pastes; (4) molding, rotating, casting, pressing, and stamping; (5) drying; (6) firing; (7) glazes; (8) colors. (*B*) *Special ceramics:* (1) brick and building ceramics; (2) refractory products: (*a*) clay grog objects; (3) pottery products; (4) white ware; (5) stoneware; (6) porcelain.

M. V. KONDOIDY

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of the
AMERICAN CERAMIC SOCIETY

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The American Ceramic Society

2525 North High Street

Columbus, Ohio

CERAMIC ABSTRACTS

Compiled by

The American Ceramic Society

ROSS C. PURDY, *Editor*

LOIS PURDY TURNER
EMILY C. VAN SCHOICK
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VOLUME 10, 1931

Editorial and Advertising Offices: 2525 North High Street, Columbus, Ohio
Publication Office: 20th and Northampton Sts., Easton, Pa.

Abstractors: H. W. Alexander, A. Ally, C. R. Amberg, A. A. Ayars, R. Barta, L. T. Brownmiller, E. C. Clemens, W. M. Cohn, R. H. Ewell, M. A. Ewer, C. G. Harman, R. A. Heindl, E. B. Hewitt, M. Y. Hodgdon, H. Insley, S. Kondo, M. V. Kondoidy, K. Lark-Horovitz, W. Lerch, J. T. Littleton, G. H. McIntyre, T. N. McVay, W. W. Meyer, R. G. Mills, A. J. Monack, S. I. Perkal, J. D. Redue, E. P. Rexford, D. E. Sharp, G R. Shelton, H. H. Stephenson, J. G. Tolpin, E. J. Vachuska, M. J. G. Westfeldt, A. E. R. Westman, W. C. O. White.

How To Make This Society Great

¶ "Men become great only through use of their faculties in behalf of their fellowmen."

¶ "Organizations are built of human units."

¶ "They become great by service."

¶ "Insofar as they reflect the high and noble ideals of their members, they grow in influence and prestige."

(Taken from General Orton's induction remarks, page 93, Bulletin American Ceramic Society, April, 1931.)

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Can you expect standardized Frit to be universally adaptable? Why not Frits that Fit?

Ask us.

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Manufacturers of chemicals and enamel frit.

Ceramic Materials Division

1204 Keith Building, Cleveland, O.

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 10 **December, 1931** **No. 12**

EDITORIAL

ECONOMY IN RESEARCH ACTIVITIES

Our universities, our governmental research laboratories, our technical societies, and our trade associations are established for the same end purposes. The same sustaining financial program is used for all these organized activities. Each is equipped to perform particular tasks but the total of the work of these organizations is to advance the economic welfare of the people.

No society or association and no governmental, educational, or research agency is economically or morally independent of the other organized activities. For the maximum accomplishment there must be an intimate collaboration.

Each of these organizations must (1) equip itself to accomplish all that it can in its appointed field, (2) make its work known, and (3) by its own efforts, be as prominent as possible in this game of advancing the people's welfare.

There is no selfishness in an individual organization in making itself as able as possible or in seeking the largest possible scope of activities. The

strength of the whole community or group interest is the total of the strengths of individual units. It behooves each one to help the others in their efforts to gain ability and opportunity to serve.

The people authorize, delegate, and finance the governmental agencies to prosecute researches. The agencies are answerable to the people.

These same people organize trade and technical societies, each for a particular industrial group for the purpose of developing, recording, and applying information pertinent to their welfare. Thus collectively, the people finance the governmental and school agencies and separately by industries they maintain societies to obtain and apply information.

The public institutions and the technical societies have a common fountain head. It is fitting, therefore, that each of these organized groups shall keep in mind the distinctive service which it is to render in the general scheme of affairs as designed by the people for their collective and individual welfare.

This SOCIETY has announced that it will not print in its *Journal* any paper which will appear elsewhere in English other than as a reprint from its *Journal*. This ruling means that if a governmental or school research organization shall decide that a part of the money appropriated to it for research shall be spent in publishing research results in bulletins or journals of its own, none of the people's money need be spent in a duplicate printing of these reports in the *Journal* of the people's society. If publishing their research results in their own journals and bulletins would serve the best interests of the public research bureaus and stations, this practice would at the same time be beneficial to the separate group societies and associations.

What is best for one is best for all in this general and specialized organization scheme by and for the people. The question then is: What practice is the best for all concerned?

Is it of more value to governmental bureaus or experiments station to spend money in printing and distributing the results of their researches without regard to the special groups interested rather than to conserve their appropriated money for the purpose for which it was intended and leave to each particular group to print and distribute the research reports in which it is interested?

This problem is not prompted by the present business depression. It is prompted by an analytical study of the rôle which the industrial societies should play in conjunction with the public research institutions.

The AMERICAN CERAMIC SOCIETY will continue its support of the governmental research institutions but it will not spend the people's money on duplicate publication of research reports.

ACTIVITIES OF THE SOCIETY

REPORT OF COMMITTEE ON PUBLICATIONS[1]

Duplicate Publications

J. T. Littleton presided at the meeting and in opening reviewed the conditions necessitating the call for a meeting of the Committee on Publications. The chief reason was that of deciding definitely a policy for the Editorial Office of the *Journal of the American Ceramic Society* to follow in regard to the printing of papers presented for duplicate publication in the *Journal of the American Ceramic Society* and elsewhere at about the same time. Instances were given of papers published (1) in the *Journal of the American Ceramic Society* and in the *Journal of Research* of the Bureau of Standards, and (2) in the *Journal of the American Ceramic Society* and in bulletins of university experiment stations.

It was shown that a period of three months is required to prepare a paper from the manuscript stage to the printed journal form and that any attempt to shorten the period of time requires a disruption of schedules of papers and considerable effort and money. Due to the large number of papers awaiting publication and due to the very limited finances at hand it is essential that space in the *Journal* be given to papers whose only appearance will be in the *Journal of the American Ceramic Society*.

Discussion brought out the rulings stated in the Constitution of the AMERICAN CERAMIC SOCIETY pertaining to the subject. Article XI on the subject of "Publications" contains paragraphs (3) and (4) of interest in this connection (*Bull. Amer. Ceram. Soc.*, **10** [7], 253 (1931)).

Article XI

(3) In the consideration of papers offered for presentation or publication those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purpose of the SOCIETY shall be rejected. The Committee on Publications shall determine which papers shall be printed. The Committee may return a paper to the writer for change or correction and may call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it.

(4) All papers, discussions, and other writings which have been presented before the SOCIETY, its Divisions, or Sections, and all committee reports shall become the property of the SOCIETY. Their publication or other disposition shall be in the hands of the Committee on Publications.

Any papers, discussions, or writings not considered suitable for use in the publications of the SOCIETY by the Committee on Publications must be released or returned to the authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered within sixty days.

No reports prepared by a regularly appointed committee of the SOCIETY or of its Divisions or Sections shall be offered for publication elsewhere until the Committee on Publications shall have been given an opportunity of accepting such reports for publication by the SOCIETY.

Questions were asked regarding the attitude of other societies in this matter and discussion disclosed the fact that several societies maintain the ownership of papers presented at their meetings, and then release these papers officially for publication elsewhere. These societies believe that the single appearance of a paper in full is sufficient. Abstracts of such papers then appear in the course of time in several journals, according to their interests.

Resolution I

The attitude of the Committee may be sensed from the following resolution which was passed unanimously, namely,

[1] Meeting held September 12, 1931.

That the AMERICAN CERAMIC SOCIETY shall not accept for publication in its *Journal*, papers which will appear in print elsewhere in the same language, and that this ruling shall go into effect as soon as the papers now in the Editorial Office are disposed of.

(A list of papers was submitted to the Publications Committee by Mr. Purdy in his letter of September 8.)

Formation of Division Publications Committees

Due to the large number of papers passing through the Editorial Office, it was suggested that the examples set by the Glass and Refractories Divisions in creating Division Publications Committees be followed by other Divisions. It was felt that each Publications Committee should read and critically review papers presented to their Division for publication. It was understood that where necessary the main Committee on Publications should be called upon to render final decisions, as stated in the Constitution.

Resolution II

A resolution was therefore made and passed to the effect that

The Committee on Publications advises each Division of the SOCIETY to form and organize a Division Publications Committee; and that these Division Publications Committees shall draw up uniform operating rules for their guidance.

LOUIS NAVIAS, *Secretary pro tempore*

The following letter was received by J. T. Littleton, Corning Glass Works, from the editor of the *Journal of the Optical Society of America* and *Review of Scientific Instruments*.

327 Craft Ave.,
Pittsburgh, Pa.
September 19, 1931

Replying to your letter of September 17, some of the papers which we are publishing in the *Optical Journal* coming from the Bureau of Standards are published simultaneously in the Bureau of Standards *Journal of Research*. In general, I discourage duplicate publication and it is only on articles of very great importance to our readers that we consent to publish an article when we know it is to be printed elsewhere. Several of the papers submitted to us by the Bureau have been of such a detailed nature that the article would not be desirable for the Bureau of Standards *Journal of Research*. Also quite a number of the papers published have been in the nature of committee reports. Members of the Bureau staff have contributed to joint committee reports quite unofficially, as far as their government duties are concerned.

I suppose you are having some trouble with the government institutions as our Society has had. The Chemical Society has also given the matter some consideration. At the last meeting of the council of our Society we passed a resolution to the effect that members of the government institutions as well as other institutions, in order to make it general, cannot present papers at official Society meetings unless there is a *bona fide* intention to submit the paper for prior publication in Society journals. A similar resolution was passed by the Chemical Society and is having a splendid effect in curtailing independent policy of chiefs of government bureaus. If you care to enforce this rule, you see you have a very powerful lever. Continued action of the government bureau chiefs would simply throw the members of their staff out of active participation in national society transactions. I have been rather liberal but hope that your Society will err in the other direction.

PAUL D. FOOTE

LOCAL SECTION NEWS

Pittsburgh Section[1]

The regular meeting of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY was held November 10 at Mellon Institute.

R. H. Heilman, Senior Fellow at Mellon Institute, addressed the Section on "Heat Loss from Bare and Insulated Walls." The lecture was illustrated with lantern slides showing many new and interesting features on insulation. After the lecture the meeting was opened for discussion.

THANK YOU! MAY WE HAVE MORE SUCH TESTIMONIALS

From One Friend to Another

At odd times I have given a good deal of thought to your remarks concerning the *Journal of the American Ceramic Society* expressed at the last meeting of the local section, and while it is none of my business, I am just wondering if you have not been overlooking a good bet.

Some of us are just natural born readers who lap up everything we can get our hands on, whereas there are others to whom reading is a bore and a nuisance. I am absolutely sure, however, from the nature of the work you have done and the systematic manner in which you carry on this work that you must do a great deal of reading, or must have done so in the past. Personally, I find that for every hour I spend in reading I may save myself several hours of duplication of effort in trying to find out by experiments what someone else has already learned and has published.

As I stated at the meeting, the *Journal* goes through our Works every month. This does not necessarily imply that every one of our key men reads the *Journal* since such a statement would be absurd. It is a part of my job, however, to read that book from cover to cover every month and many papers which appear on the surface to have not the slightest interest for me will contain the germ of an idea that one of our boys can apply to great advantage.

Our practice is to mark each copy, in some cases a mere sentence or a paragraph at a time, to save our boys unnecessary study and to focus their attention only upon those points which we think will prove of value.

Personally, I have found the abstract section of the *Journal* to be a veritable ceramic literary digest. I no longer bore through scores of technical publications which used to require days upon days of my time every month. As soon as the *Journal* comes in I read the abstracts in their entirety and check those which appear to have some practical or scientific value. The publications abstracted are then sent for in order to make a more complete study of the subject presented. This section alone in the *Journal* has paid handsome dividends in a saving of time and in keeping us posted on the progress of the ceramic world.

You know me well enough to realize that I have no axe to grind here and that what I have written has been laid before you solely with the thought of helpful coöperation.

T. S. CURTIS, *Vice-President in Charge of Research*, VITREFRAX CORPORATION

Our Abstracts

In regard to your letter of October 14 to Mr. Poste, I am particularly interested in the discussion regarding abstracts which had the heading "Fewer and Better Abstracts."

---

[1] Herman G. Wilcox, *Secretary*.

I am inclined to agree with you entirely in your defense of the *Abstracts* as they are now published, for I believe that you are doing a very good job with them. I never fail to go over them in each issue of the *Journal*, and we have often obtained information of great value and benefit from them. I think it is perfectly satisfactory to make the abtracts as short as possible, covering only the high spots, because if one is interested he will obtain the complete article regardless of the length of the abstract. However, I do not favor doing any less of it, even though some of them may be of little value, because in reducing them there is always a danger of omitting something that may be of great value to many of us.

I am also much interested in your discussion of the abstracts of patents. These abstracts are very valuable to us and I certainly hope they will be continued. Here again, I do not think it is necessary to go into any detail, the title and a very brief statement being sufficient in most all cases, but if they were entirely omitted I, for one, would lose a contact with new patent developments that I have continually made use of. It is probably a fact that many of our members are interested in products in which the patent situation is not of much importance, but on the other hand, I know there are many ceramic products besides ours where patents are of importance, and for that reason I believe that there is a sufficient number of members interested in these patent abstracts to warrant their continuance.

I hope that the suggestion of condensing both the patent and paper abstracts will help sufficiently from the standpoint of economy that you will be able to continue to cover the same ground in this more condensed manner as you are now doing in such a fine way.

E. H. FRITZ

ADDITIONS TO OUR MUSEUM

Brick from First Brick Church in America

The brick presented to you by Mr. White, Mr. Oakley, and Mr. Navias was actually found by Mr. Cook who conducted our party to Jamestown, Williamsburg, and Yorktown.

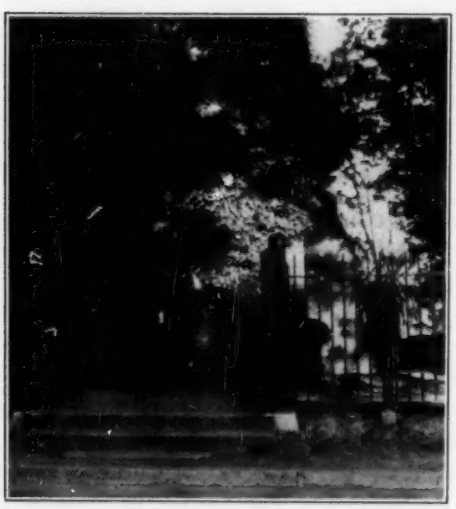

FIG. 1.

The brick was taken from the first church of brick constructed in America. This church was erected between 1639 and 1647. It was destroyed by fire during the Bacon Rebellion in 1676. The tower continued to stand. Toward the close of the eighteenth century, the body of the church had fallen to decay and its walls collapsed. The chapel now standing on the site of the church was reconstructed in 1907 by the Colonial Dames of America. The graveyard about this church is thought to date back as far as 1617 or possibly earlier.

Figure 1 shows how it looks since its replacement in 1907. Figure 2 illustrates how extremely

old it is. Figure 3 shows the first brick house in America. The writer has one of these bricks in his possession.

E. L. HETTINGER

A Historic Tile

I am sending you an antique wall tile from Carthage for your collection. This was given to me by Mr. P. R. Bullard of the Golding-Keene Co., Keene, N. H.

FIG. 2.

FIG. 3.

Mr. Bullard, on a recent trip to Europe, picked up a number of these and was kind enough to send me one of them. I am sending it to you because I know it will do more good and will be seen by more people in the AMERICAN CERAMIC SOCIETY'S collection than in my office.

This tile comes from an old Moorish home with an authenticated history of 500 years.

F. C. FLINT

BY-LAWS OF THE ENAMEL DIVISION AMERICAN CERAMIC SOCIETY[1]

I. Purpose

The purpose is to stimulate interest in the technical development of the enameling branch of the ceramic industry through

(1) The presentation and discussion of technical and scientific papers relating to the raw materials, processes of manufacture, and finished products of the same.

(2) The consideration of any scientific or industrial problems pertaining to metal enameling except those relating solely to trade, prices, labor, tariff, sales methods, etc., providing that this shall not be interpreted to exclude the discussion of cost of manufacture or the application of efficiency methods to manufacturing problems.

[1] Adopted May, 1927.

(3) The promotion of coöperative scientific and industrial research in metal enameling.

II. Membership

The membership shall consist of all members of the AMERICAN CERAMIC SOCIETY interested in enameling who shall indicate their desire to join the Division.

III. Meetings

The Division shall meet in conjunction with the Annual Meeting of the parent SOCIETY and at such other times and places as the Executive Committee shall decide.

IV. Officers

(1) The officers of the Division shall consist of a Chairman and a Secretary who shall perform the duties ordinarily pertaining to these offices. The officers, the member representing the Division on the Board of Trustees, and a Council of four members shall constitute an Executive Committee which shall manage the affairs of the Division. The officers and two councilors of the Division shall be elected annually by ballot at the last session of the Division held during the Annual Meeting of the SOCIETY and shall take office at the close of the Meeting at which they are elected. The Chairman shall not be eligible for immediate re-election.

(2) All vacancies occurring during the year shall be filled by appointment by the Executive Committee, and a person so appointed shall not forfeit the privilege of subsequent election to the same office.

V. Representation on Nominating Committee of Society

At the final session of the Division at the Annual Meeting, two members of the Division will be elected as representatives on the General Nominating Committee of the SOCIETY. The two representatives elected will draw to determine which shall serve on Committee No. 1 and which on Committee No. 2 and the names and designations of these elected members will be immediately reported to the Secretary of the SOCIETY by the Division Chairman.

VI. Division Nominating Committee

This committee shall consist of the above two members of the General Nominating Committee and in addition a Chairman who shall be appointed by the new Chairman of the Division within thirty days after the Annual Meeting.

(1) Duties of Nominating Committee

(*a*) *Division Officers.* It shall be the duty of the Nominating Committee to make one nomination each for the offices of Chairman and Secretary, two for Councilors, and two for representatives on the Nominating Committee of the SOCIETY. The nominations shall be announced to the Division by letter not later than forty-five days before the Annual Meeting.

Ten members of the Division can make a nomination by sending a formal petition to the Chairman of the Division at the first regular session of the Division at the Annual Meeting of the SOCIETY.

(*b*) *Trustee.* In the year in which a Trustee for the Enamel Division is to be elected, the Nominating Committee shall place in nomination two candidates for this office. A ballot containing these nominations and a space for the insertion of the name of any other candidate desired by a voting member shall be mailed to the members of the Division by the Secretary not later than June 1. These ballots are to be returned to the Secretary not later than July 1. The candidate receiving the largest number of votes shall be certified to the Secretary of the SOCIETY as the nominee from the Enamel Division to appear on the ballot of the SOCIETY.

VII. Standing Committees

The following standing committees shall be appointed each year by the Division Chairman: Membership, Rules, Standardization of Tests, Research, Data, and Educa-

tion. The Chairman of each of these Committees shall act as the Division representative on the SOCIETY'S General Committee.

VIII. Special Committees

The Chairman of the Division shall appoint such additional committees as he may deem necessary, all committee appointments to be subject to the approval of the Executive Committee of the Division.

IX. Rules Governing the Presentation of Papers

(*a*) The time allowed for the presentation of any paper or discussion before any meeting of this Division shall be limited to fifteen minutes unless otherwise ordered by vote of the members present.

(*b*) The presentation of details of procedure or processes of established practice is to be discouraged save as essential for the purpose of criticism or development of new ideas.

(*c*) Sets of numerical data or values should be presented in the form of lantern slides or diagrams.

(*d*) Papers dealing with materials or products designated only by trade may not be presented before the Division unless the trade name is one in general use for a material of well-known composition, or unless sufficient data are given to identify completely the material in a scientific manner.

X. Publication of Papers

No paper, discussion, or other writing, which may be of interest or value to the SOCIETY if published, which has been presented before this Division shall be offered for publication elsewhere until the Committee on Publications shall have had the option of accepting the same for use in the *Journal of the American Ceramic Society*.

No Committee reports prepared by a committee of this Division shall be offered for publication elsewhere until the Committee on Publications shall have had the option of accepting the same for use in the *Journal of the American Ceramic Society*.

XI. Quorum

Ten per cent of the membership of the Division shall constitute a quorum. A majority shall rule except as otherwise specified in the By-Laws.

XII. Amending the By-Laws

Any proposed amendment to these By-Laws must be presented in writing at a regular meeting of the Division and if approved by the Committee on Rules or by any ten members, must be printed on ballot and sent out. If the letter ballot shows an affirmative vote of not less than two-thirds of the total vote cast within thirty days after mailing, the same shall be declared carried and shall at once become effective. Any such portion of these laws which do not conflict with the laws of the SOCIETY shall be valid.

NOMINATIONS FOR OFFICERS, 1932–1933

The following names were submitted by the nominating committees:

President: E. P. Poste
Vice-President: W. Keith McAfee
Treasurer: H. B. Henderson
Glass Division Trustee: Francis C. Flint
White Ware Division Trustee: Daniel Parry Forst

NEW MEMBERS RECEIVED IN OCTOBER

PERSONAL

Ross M. Evans, 1179 Orr Ave., Kittanning, Pa.; Chief Ceramist, The Continental Clay Products Corp.
Gordon S. Reblin, 660 Main St., Woburn, Mass.; Superintendent, R. Guastavino Co.

STUDENT

Ohio State University, Columbus, Ohio

Kenneth William Balsizer
H. Clay Ellinger
A. Josephine Gitter
William O. Hug
Lewis Gray Minton
John T. Russ

Pennsylvania State College, State College, Pa.

Ronald E. Griffiths
Donald Victor Oesterling

Membership Workers' Record

PERSONAL		STUDENT	
G. R. Truman	1	J. B. Shaw	2
Malcolm Blodgett	1	Office	6
Total	2	Total	8
		Grand Total	10

ROSTER CHANGES IN OCTOBER

PERSONAL*

Fear, H. E., % N. J. Markley, Warsaw, Ohio. (1228 W. 112th St., Lakewood, Ohio)
Grout, J. R., Jr., B. Mifflin Hood Co., Norwood, N. C. (Daisy, Tenn.)
Keller, W. D., 13 Conant Hall, Cambridge, Mass. (North Kansas City, Mo.)
Kenagy, William L., 44 Woodruff Place, Perth Amboy, N. J. (5145 Charles St., Philadelphia, Pa.)
Mayfield, Chester C., Brockway Clay Co., Brockway, Pa. (612 Ray Ave., New Philadelphia, Ohio)
Moody, H. Leslie, 695 Eppley Ave., Zanesville, Ohio. (1912 N. High St., Columbus, Ohio)
Owens, J. B., Route 2, Box 223A, Kome Ave., Homestead, Florida. (32 Snediker Ave., Brooklyn, N. Y.)
Roemer, Orland A., 268 W 1st St., Spencer, Iowa. (Sherburn, Minn.)
Shaw, Myril C., 66 W. Tenth Ave., Columbus, Ohio. (Roseville, Ohio)
Spurrier, Harry, 9600 Dexter Blvd., Detroit, Mich. (Birmingham, Mich.)

NOTES AND NEWS

CONFERENCE ON FIRING

A conference on firing will be held at the Roseville Experimental Plant of the Ohio State University, December 17, 18, and 19. The sessions will begin at 1:00 P.M. Thursday, December 17, and will end at noon on Saturday, December 19. The following program has been outlined:

* Addresses within the parentheses represent the old addresses.

These roster changes which appear each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

(1) Fuels, by H. E. Nold and E. V. O'Rourke
(2) Combustion, by D. J. Demorest
(3) Flue-Gas Analysis, by W. E. Rice and C. A. Austin
(4) Kiln Draft and Heat Distribution, by J. L. Carruthers
(5) Pyrometry, by T. A. Klinefelter and G. A. Bole
(6) Kiln Firing, by C. B. Harrop and F. M. Hartford
(7) Research in Kiln Firing, by W. E. Rice and C. A. Austin

The course is planned to be of greatest benefit to plant operators. This work leads up to a report on the research work which has been carried on for two years by the Engineering Experiment Station in coöperation with the Federal Bureau of Mines, Fuels Division.

The lectures will in each case be followed by laboratory and plant demonstrations. An elaborate equipment for kiln tests has been set up at Roseville, in which coal is fired in two types of stokers and on dead bottom and horizontal grates in hand-fired furnaces. The gas firing of periodic kilns will also be demonstrated.

This will be a fine opportunity for plant men to get needed fundamental information in regard to fuels, combustion, methods of firing, and the control problems involved in the firing of ceramic ware. A discussion will follow each lecture period. The course is planned to interest those firing any type of fuel in any type of kiln, whether the ware be fine ware or structural clay ware. Visits will be made to plants firing structural clay ware, tile, stoneware, and tableware and the firing systems will be explained in the light of the information given during the lecture and laboratory period.

All are invited and no charge will be made for the conference. Further information and reservations may be obtained from G. A. Bole, Lord Hall, Ohio State University, Columbus, Ohio.

GLASS INDUSTRY EXHIBITION

An exhibition illustrating the more important developments of recent researches in glass technology was opened at the Science Museum, London, England, by Sir Richard Gregory on October 21 and will remain open until December 31. The exhibition is intended to show the many technical advances and the numerous improvements in the physical and chemical properties which have resulted from the scientific work carried out on many types of glass during the past fifteen years. The procedure of the research worker is illustrated by specimens, descriptions, diagrams, and apparatus. Other features of the exhibition are a series of films showing glassmaking processes, popular lectures on various subjects, and demonstrations.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931–January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	March 14–18, 1932	New Orleans, La.
American Engineering Council	January 14–16, 1932	Washington, D. C.
American Foundrymen's Assn.	May 2–6, 1932	Philadelphia, Pa.
American Gas Assn.	October 10–16, 1932	Atlantic City, N. J.
American Institute of Chemical Engineers	December 9–11	Atlantic City, N. J.

American Society for Testing Materials	June 20–24, 1932	Atlantic City, N. J.
Common Brick Mfrs. of America	February 1–6, 1932	Louisville, Ky.
Electrochemical Society	April 21–23, 1932	Baltimore, Md.
Gypsum Assn.	December 9	Chicago, Ill.
National Assn. of Manufacturers of Pressed and Blown Glassware	March 8, 1932	Pittsburgh, Pa.
National Brick Manufacturers Research Foundation	February 7–13, 1932	Washington, D. C.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Paving Brick Assn.	February 10–12, 1932	Chicago, Ill.
New Jersey Clay Workers Assn.	December 18	New Brunswick, N. J.
Optical Society of America	February 25–27, 1932	Cambridge, Mass.
Sand-Lime Brick Assn.	February 3–4, 1932	Washington, D. C.
Scientific Apparatus Makers of America	May, 1932	Wernersville, Pa.
Society of Rheology	December 28–30	Rochester, N. Y.
Structural Clay Tile Assn.	February 17–19, 1932	Chicago, Ill.
Taylor Society, Inc.	December 2–4	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12, 1932	Rochester, N. Y.

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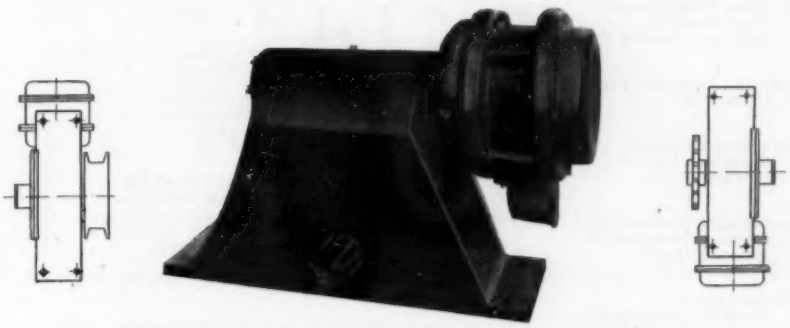

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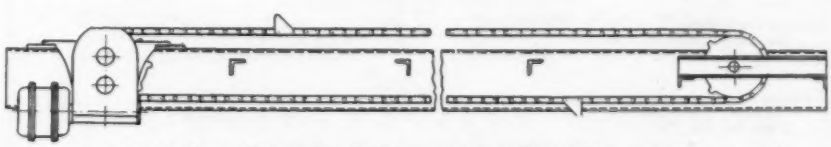

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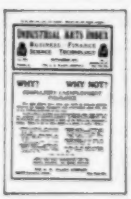

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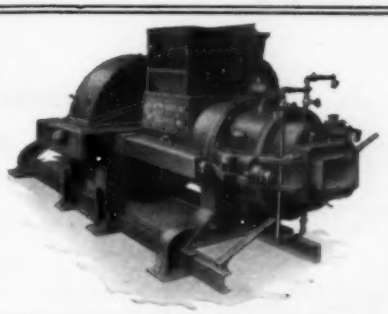

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Nitrates (Cobalt, Sodium)
Harshaw Chemical Co.
Hommel, O., Co.

O

Opacifiers
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.

Orifice Plates
Brown Instrument Co.

Oxides
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
National Paint & Manganese Co.
Pennsylvania Salt Mfg. Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.

Pebble Mills
Hommel, O., Co.

Pins
Potters Supply Co.

Placing Sand
National Silica Co.
Pennsylvania Pulverizing Co.

Plant Design
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Plate Feeders
Chambers Brothers Co.

Plate (Filter)
Norton Co.

Polariscope
Simplex Engineering Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Pot Furnaces
Simplex Engineering Co.
Swindell-Dressler Corp.

Potash (Carbonate)
Harshaw Chemical Co.
Hommel, O., Co.

Potassium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Potentiometers (Indicating, Recording, Controlling)
Brown Instrument Co.

Producer Plants
Simplex Engineering Co.

Protecting Tubes, Thermocouple
Brown Instrument Co.

Protective Equipment
Willson Products, Inc.

Pug Mills
Chambers Brothers Co.

Pulverizing Mills
Hommel, O., Co.

Pyrometers (Indicating)
Brown Instrument Co.

Pyrometers (Recording)
Brown Instrument Co.

Pyrometer (Switches)
Brown Instrument Co.

Pyrometer Thermocouples
Brown Instrument Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
McDanel Refractory Porcelain Co.

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PA.

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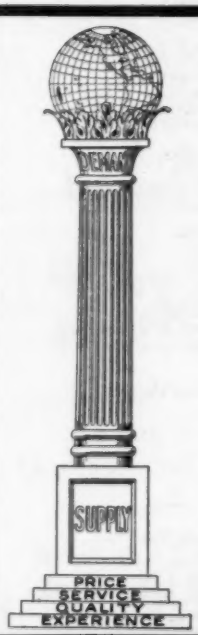

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BUYERS' GUIDE (continued)

R

Recorders (CO, CO_2, SO_2 and Draft)
Brown Instrument Co.

Recording Instruments
Brown Instrument Co.

Refractories
Carborundum Co.
The Exolon Co.
Norton Co.

Refractory Materials
The Exolon Co.
Norton Co.

Regulators (Automatic Temperature)
Brown Instrument Co.

Remote Controllers, Indicators, Recorders
Brown Instrument Co.

Respirator
Willson Products, Inc.

Rutile
Harshaw Chemical Co.
Titanium Alloy Mfg. Co.

S

Safety Devices
Willson Products, Inc.

Sagger Presses
Chambers Brothers Co.

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Harshaw Chemical Co.
Philadelphia Quartz Co.

Silicon Carbide
The Exolon Co.
Norton Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.
Harshaw Chemical Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.
Porcelain Enamel & Mfg. Co.

Soda Ash
Harshaw Chemical Co.
Hommel, O., Co.

Sodium Antimonate
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Vitro Mfg. Co.

Sodium Fluoride
Harshaw Chemical Co.
Hommel, O., Co.

Spar
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Switches
Brown Instrument Co.

T

Tachometers
Brown Instrument Co.

Talc
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
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Simplex Engineering Co.

Temperature Controls
Brown Instrument Co.

Temperature Instruments (Measuring)
Brown Instrument Co.

Thermocouples
Brown Instrument Co.

Thermometers (Electric Resistance, Indicating, etc.)
Brown Instrument Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Norton Co.

Tile (Wall)
Paper Makers Importing Co.

Time Cycle Controller for Tunnel Kiln Pushers
Swindell-Dressler Corp.

Tin Oxide
Drakenfield & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.

Titanium
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Brown Instrument Co.
McDanel Refractory Porcelain Co.
Norton Co.

V

Valves (Automatic Control)
Brown Instrument Co.
The Denison Engineering Co.

Venturi Meters
Brown Instrument Co.

V-Notch Meters
Brown Instrument Co.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Witherite
Harshaw Chemical Co.

Z

Zirconia
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.
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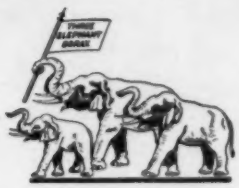

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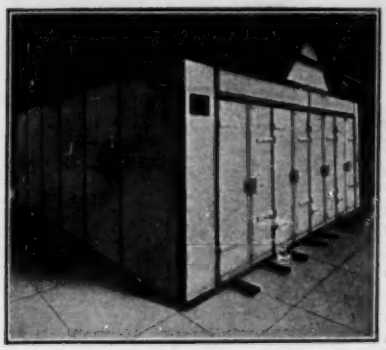

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